Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN ENGINEERING
FIVE DOLLARS A YEAR

APRIL 1956

Mechanical Problems in
Nuclear Reactors

Colored Aluminum

Dashpot Dampers

Driving Inertia Loads

100 kw submerged reactor — page 187

Here's how C/R COOPERATIVE RESEARCH *can help you*

HELP YOU ENGINEER YOUR PRODUCT, ELIMINATE TOUGH TROUBLE SPOTS AND SAVE YOU MONEY IN FLUID SEALING AND RELATED FIELDS

Developing a new product or rectifying trouble in a present one? Why not supplement your own engineering facilities with C/R Cooperative Research? In the areas related to oil seal design, lubricant, chemical, gas, or air retention, and foreign matter exclusion—as well as in the development of synthetic rubber and impregnated mechanical leather parts—Chicago Rawhide's developmental facilities are the most extensive in the country.

All of them are at your service . . . for help with your critical or unusual problems. You may be sure that your design specifications, performance requirements, and production controls will be met to the letter. A few of the many ways in which C/R Cooperative Research serves other leading manufacturers are pointed out on this page. We'll be glad to help you.

INFORMATION . . . Comprehensive brochures and catalogs are available to give you the complete scope of C/R products and services. Write for your copies, and please indicate your area of interest.

DESIGN . . . When your product is on the drawing board is the time to correlate design and materials with performance requirements. C/R's expertly-staffed engineering groups working in close cooperation with the material labs have done it for others . . . and can do it for you.

MATERIALS . . . Pioneers in the development of Sirvis (mechanical leather) and Sirvene (synthetic rubber) parts for oil seals and other mechanical applications, C/R will custom-develop materials for your special needs in our synthetic rubber or leather laboratories.

PRODUCT TESTING . . . Many products, new and present, need extensive checking. C/R testing labs often work many months to verify designs, eliminate trouble. This is standard procedure on all C/R stock products . . . essential in developing yours.

TROUBLE SHOOTING . . . Auto and heavy equipment makers, as well as manufacturers in most fields you can think of, have solved difficult sealing and related problems with the help of C/R Cooperative Research. You can, too . . . and save time, trouble and money.

PRODUCTION . . . Six plants, operating as extensions of C/R Cooperative Research, provide laboratory-like quality control, timed to your needs. C/R Sales Engineering follows through to coordinate and assure satisfaction.

EXPERIENCE . . . Broadest in the field. Proof? More automobiles, farm equipment and industrial machines rely on C/R Oil Seals than on any similar sealing device. C/R diaphragms, boots and gaskets are in the same top categories.

C/R

CHICAGO RAWHIDE

CHICAGO RAWHIDE MANUFACTURING COMPANY
1237 Elston Avenue, Chicago 22, Illinois
Offices in 55 principal cities

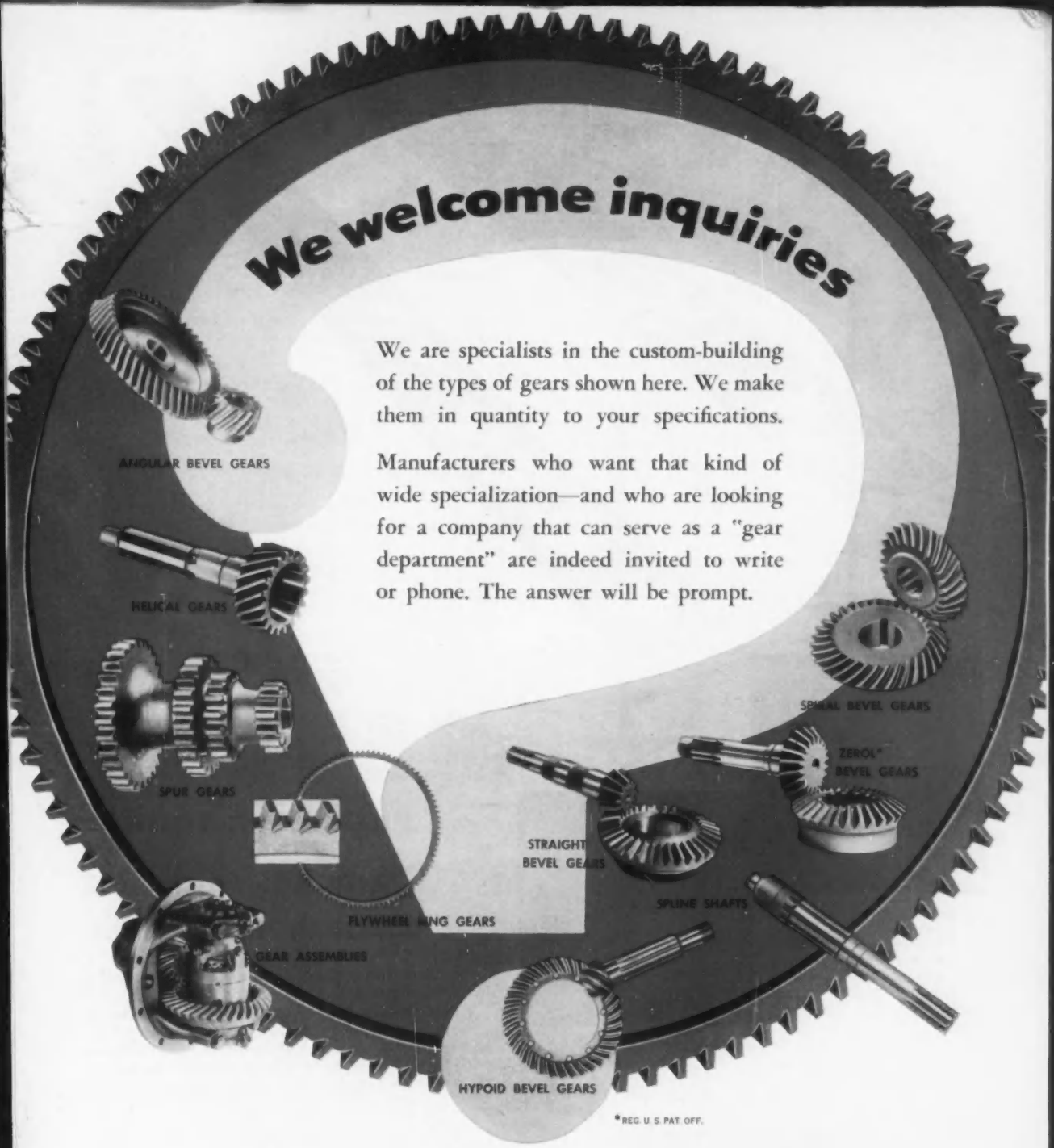
In Canada: Super Oil Seal Mfg. Co., Ltd., Hamilton, Ontario
Export Sales: Geon International Corp., Great Neck, New York

C/R Products
C/R Shaft & End Face Seals • Sirvene (synthetic rubber) molded pliable parts • Sirvis-Cooper mechanical leather cups, packings, boots • C/R Non-metallic Gears

We welcome inquiries

We are specialists in the custom-building of the types of gears shown here. We make them in quantity to your specifications.

Manufacturers who want that kind of wide specialization—and who are looking for a company that can serve as a "gear department" are indeed invited to write or phone. The answer will be prompt.



*REG. U. S. PAT. OFF.

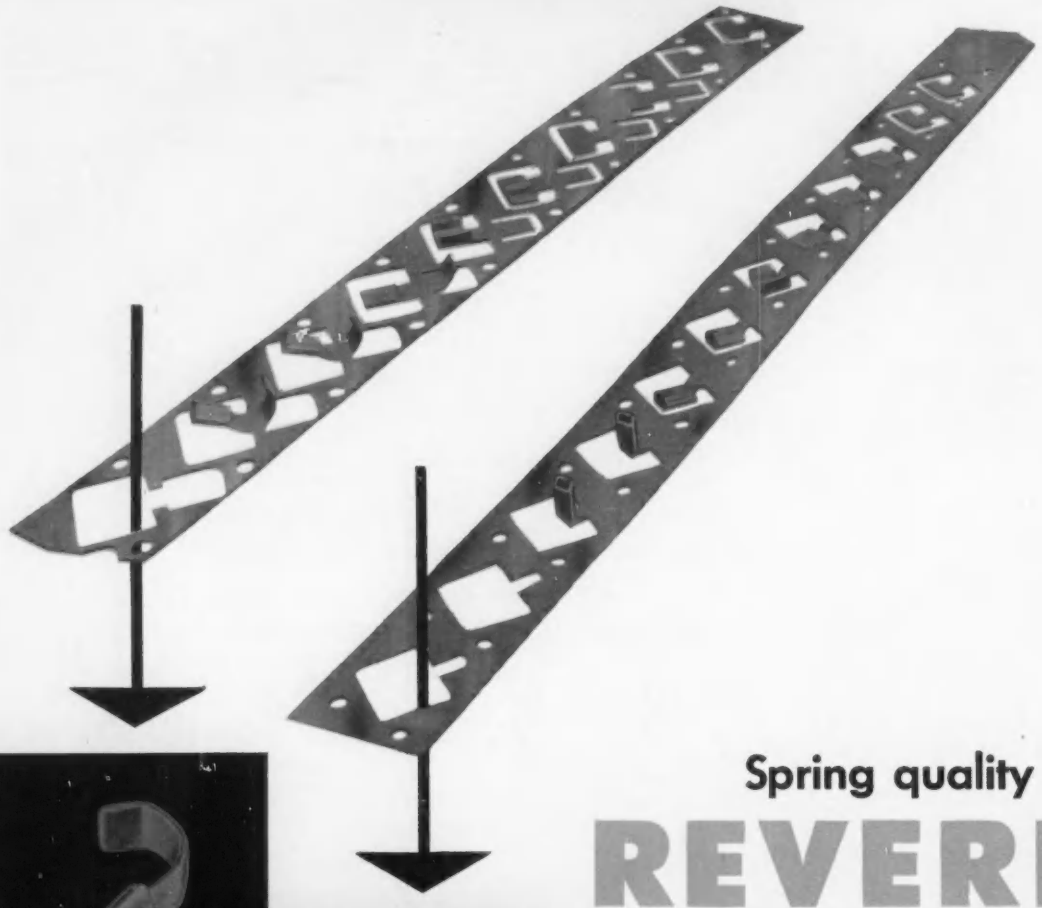
DOUBLE DIAMOND GEARS

FOR AUTOMOTIVE, FARM EQUIPMENT AND GENERAL INDUSTRIAL APPLICATIONS
GEAR-MAKERS TO LEADING MANUFACTURERS

Automotive Gear Works, inc.

ESTABLISHED IN 1914

RICHMOND, INDIANA



Two types of Krueger and Hudepohl clips, and strips showing progressive stages in fabrication.

Spring quality of

REVERE

PHOSPHOR BRONZE

makes solderless connections possible

It is not always the case that solder has to be used to make good electrical connections. Often phosphor bronze clips can be used, tightness being achieved through the hard-gripping spring quality of this metal. Take the clips made by Krueger and Hudepohl, Inc., Cincinnati 2, Ohio. This company uses Grade A 5% Revere Phosphor Bronze to make its connections for refrigerators, and for submersible pumps and hydraulic control units. Such services require not only tight permanent connections, but the ability to withstand severe temperature variations, as well as vibration. Revere Phosphor Bronze meets the needs perfectly. In developing this application, the Revere Technical Advisory Service collaborated closely with the customer on the important matter of temper required both for fabrication and end use. Krueger and Hudepohl report no rejects. The metal is supplied in the form of strip, one inch wide, and in very long coils, so that down time for coil set-up on each progressive die machine is minimized. Send for your free copy of "Revere Phosphor Bronze," which provides details about qualities, performance, and applications.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N. Y.

• • •

Mills: Baltimore, Md.; Brooklyn, N. Y.; Chicago, Clinton and Joliet, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Newport, Ark.; Rome, N. Y. Sales Offices in Principal Cities, Distributors Everywhere.

"The Revere Four-Way Service" is a 16mm sound motion picture in color, interesting and informative. If you would like to see it, write nearest Revere Sales Office.

Product Engineering

APRIL 1956 Vol. 27 No. 4 The McGraw-Hill Magazine of Design Engineering

Prefinished Aluminum ..... R. V. Vanden Berg 135
How electrochemical, paint and electroplated coatings withstand forming operations; specific limitations for each method; mill products in prefinished chemical color.

Column Formulas—Four Basic Types ..... Glen H. Howell 139
Characteristics compared; chart shows combinations to use for various applications.

Driving High-Inertia Loads ..... Charles C. Libby 142
How to select the best combination of flywheel inertia and motor for constant-running machines with cyclic loads; motor speed-torque curves under cyclic loads.

Design Features in New Products 148
Hydraulically powered crane; unitized screw machine; four case histories in die casting design; variable-speed portable generator; air-lubricated dividing table; remote controlled machine; calibrated impact tool; vibration pick-up uses "C" springs.

Calculating Damping Factors for Dashpots—A Staff Report 162
Equations that permit design on paper instead of construction and test of models, applicable for both linear and rotary types.

Designing for Investment Casting ..... John E. Srawley 166
Advantages and limitations of the method; tolerances obtainable, types of pattern materials and casting alloys; alloy specification and inspection procedures.

Design Engineers Exhibition 170
More information about the Design Engineering Show in Philadelphia May 14-17.

Curve Fitting with Orthogonal Polynomials ..... Charles R. Sexton 171
Method uses tables and a computation chart for a calculating machine operator.

Corrosion Resistance of Stainless Thread Inserts in Light Alloys .... Paul Wolfe 176
Salt spray tests show no added finish is needed on inserts in aluminum or magnesium.

Computing Mechanisms—II 180
Concluding article pictures designs for multiplying, dividing, differentiating and integrating.

Plastic-Bound Magnets ..... Gerhard Hennig 182
Resin mixed with fine particles of Alnico or other magnetic material molded as a plastic; physical and mechanical properties; advantages, limitations and applications.

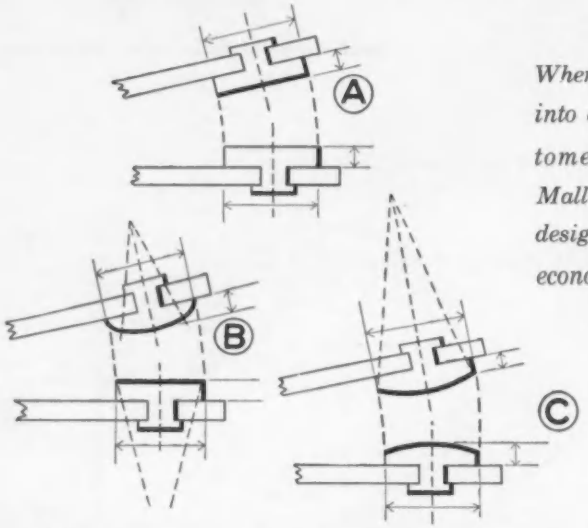
Nuclear Reactors Pose New Problems in Mechanical Design—A Staff Report ... 187
Materials: conductivity and reflectivity of neutron radiation, and effect of radiation on properties. Mechanical components: special requirements placed on valves, pumps, seals and bearings. Controls: systems for automatic operation and safety control, remote handling and viewing.

Pressure Loss in Flexible Metal Tubing ..... C. M. Daniels 223
Friction coefficients at high flow rates for corrugated metal hose.

DEVELOPMENTS TO WATCH...5
DESIGN PERSPECTIVES 129
EDITORIALS 133, 220
TECHNICAL NEWS 211
COMING EVENTS 219
NEW COMPONENTS AND MATERIALS...228
CATALOGS AND BULLETINS.....352
SANS, SOUCI 382
ENGINEERING ABSTRACTS ..390
NEW BOOKS 423
READERS' LETTERS 435
PRESS PREVIEWS 439

Number of copies printed in this issue 37,042

MALLORY



When Original Design A ran into alignment trouble, the customer proposed design B. Mallory engineers recommended design C as the most efficient and economical solution.

How economical are *your* contact designs?

Mallory Contact Engineering Offers Five Ways To Improve Economy

1. **The most effective contact material** from the extensive line developed by Mallory. More economical alloys often can satisfy *actual* service conditions.
2. **The most economical contact design . . .** for your purchasing, production and product needs.
3. **The most economical backing material** . . . from a group of Mallory alloys developed for this use.
4. **The most economical backing member design** . . . in relation to contact and product design requirements.
5. **The most economical method of assembly** of contact and backing member.

By coordinating *all* these important elements of contact design, Mallory can help you put into effect a long-range plan for cutting contact cost and assuring peak performance.

DESIGN of electrical contacts is an engineering job in which Mallory's specialized experience can often lead to substantial savings for you. A case in point—a manufacturer of circuit breakers wanted to use a combination of flat and radius-faced contacts to lick an alignment problem in production. This design required buying and stocking of two separate contact parts.

Mallory contact engineers came up with a money-saving improvement. They recommended a modified radius design to go on both the stationary and moving contacts. Substantial production time was saved by elimination of the alignment difficulty in assembly. In addition, by buying a *single* type of contact engineered for the job, instead of two separate designs, the manufacturer cut his inventory problem in half, simplified purchasing and handling, and saved a significant percentage of direct contact cost as well.

There's a good chance that you can realize comparable savings on your own contact applications, by bringing your problems to Mallory specialists. The complete engineering job that our staff can undertake will assure you of gaining the maximum in performance . . . at the peak of economy . . . for your specific requirements. For a consultation, write or call Mallory today.

Expect more . . . get more from

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

THIS MONTH'S COVER

Operation at 100 kw maximum power level produces the blue glow in the submerged core of this "swimming pool" reactor at Oak Ridge National Laboratory. Operating requirements pose special problems in mechanical control of fuel elements and moderators, as detailed in the 24-page staff written article on "Nuclear Reactors" starting on page 189 in this issue.

THE STAFF

Editor **G. F. NORDENHOLT**
Managing Editor **ROBERT W. CARSON**

Associate Editors
ROBERT E. ABBOTT • RANDOLPH P. DOMINIC
HENRY E. COOK, JR. • RICHARD M. KOFF
JAMES R. McDERMOTT

Assistant Editors
PAUL N. ANDERSON • NICHOLAS CHIRONIS
JOHN KOLB • RICHARD A. LAWRENCE
NORMA J. VAN NESS

Editorial Assistant **LILLIAN M. WITHAM**
Consulting Editor **ROBERT E. BRUCKNER**
Washington **GEORGE B. BRYANT, JR.**

Publisher **ALBERT HAUPTLI**
Advertising Sales Manager **STANLY J. ALLING**
Manager, Market Research **HUGH BRITTON**
Reader Service Manager **C. C. KANE**
Business Manager **RUSSELL T. DOUGLAS**

Foreign News Bureau: **LONDON • PARIS • BONN • RIO DE JANEIRO • MEXICO CITY • TOKYO • BOMBAY**

Product Engineering
A McGRAW-HILL PUBLICATION

APRIL, 1956 **Vol. 27, No. 4**

Published monthly, with an additional issue in Mid-October, by the McGraw-Hill Publishing Co., Inc. Executive, Editorial, Advertising and Subscription offices **McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y.** Publication office, 99-129 North Broadway, Albany 1, N. Y. Donald C. McGraw, President; Paul Montgomery, Executive Vice President; Joseph A. Gerardi, Vice President and Treasurer; John J. Cooke, Secretary; Nelson Bond, Executive Vice-President, Publications Division; Ralph B. Smith, Vice President, Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; J. E. Blackburn, Jr., Vice President and Circulation Director.

FOR SUBSCRIPTIONS, write to: Subscription Service, 330 West 42nd Street, New York 36, N. Y. Subscriptions are solicited only from executives, engineers and consultants engaged in the design of machinery and other engineered products. **Orders must indicate company and position.** Allow one month for change in address.

Single copies 50¢. United States and possessions, $3 for one year, $8 for two years, $10 for three years; Canada, $6 for one year, $9 for two years, $12 for three years; other Western Hemisphere and the Philippines, $15 for one year, $25 for two years, $30 for three years; all other countries, $25 for one year, $40 for two years, $50 for three years. Second class mail provisions authorized at Albany, N. Y. U. S. A.
Copyright 1956 by McGraw-Hill Publishing Co., Inc.—All rights reserved.

Developments

To Watch

TWO-COLOR MOLDED PLASTIC PARTS . . . .

. . . . a process heretofore limited to small parts about the size of buttons, now is being successfully applied to the manufacture of plastic dinnerware by the Plastics Mfg. Co., 825 Trunk Ave., Dallas, Texas. The material used is alpha-cellulose filled melamine formaldehyde. The largest piece made is a 15 in. by 8½ in. platter, but the company feels that the process can be applied to any thermo-setting plastic that has a preform application, with no limitation as to size or shape. Key to the process is an accurate control of the flow of materials in the mold, precise temperature control, and special die design having a highly polished surface. For the color-on-color process, as it is called, the molds must be maintained at a uniformly high temperature. In the initial step, the resin is shaped by machine into pellets of different contours, but of even depth. (The company states that the two-color molding is *not* a result of fusing two preforms of like shape and different in color, but beyond that is keeping the process a secret.) Pre-heating of the preformed melamine prior to charging the mold is necessary to get the proper finish along with improving flowability. High frequency preheating is used. After Plastic Mfg.'s special process, the part is put in the die, and the procedure follows normal compression molding. At present, only two color work is possible, and there is no "running" of one color to the other. Research is being conducted on the application of special decorative design with the two color process.

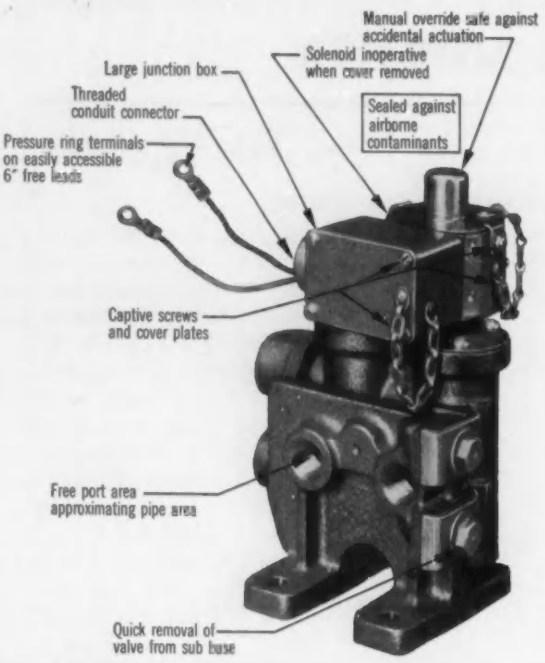
BOAT PROPELLER OF NYLON . . . .

. . . . is the recent development of the Dansk Termoplastic Industri, Copenhagen, Denmark, a firm specializing in the development of new uses for plastics. Nylon was tried in an attempt to find a material which did not suffer from cavitation. The experimental engine screw is reversible, has three blades with rounded fore-edges, and has been found to be lighter and stronger than metal screws. No galvanic effects were found when the nylon propeller was used with seaproof aluminum. In tests, heavy logs and boxes struck the blades in water with no ill effects. A boat was sent at full speed against a stony beach so that the screw was out of the water when the blades hit the bottom. Only minor indentations resulted. A set of blades will be sent to Greenland to be tested on a tugboat to determine the reaction when used in ice.

LOW COST CERAMIC PERMANENT MAGNETS . . . .

. . . . just announced by the Stackpole Carbon Co., St. Marys, Pa., are said to have high coercive force, low residual induction, and good resistance to demagnetization. The new units will retain their energy even when used without "keepers" or under other

(Continued on page 7)


Manual override safe against accidental actuation
Solenoid inoperative when cover removed
Large junction box
Threaded conduit connector
Sealed against airborne contaminants
Pressure ring terminals on easily accessible 6" free leads
Captive screws and cover plates
Free port area approximating pipe area
Quick removal of valve from sub base

For Machine Designers Who Want More Than Just 'JIC' Compliance, the Crescent® 4-Way Valve

®Product of Crescent Valve Company for the control of air, water and light oil to 150 P.S.I.

Pointed out on the photo above are the JIC features which are a must for many equipment manufacturers to gain acceptance of their machines in a growing number of production conscious plants. However, they offer obvious advantages even where they are not specifically demanded. Furthermore the JIC type Crescent solenoid is completely interchangeable with standard solenoids for the convenience of those manufacturers who want the JIC features available only for required application.

COMPETITIVE

With all its superior operating features the Crescent valve is probably the most competitively priced line on the market, particularly in the light of liberal trade and quantity discounts.

COMPACTNESS

Space, labor and materials savings have been pointed out to us by many equipment manufacturers as benefits from Crescent's compact design.

INTERCHANGEABILITY

Crescent valves can be converted to any practical current or voltage AC or DC by a simple coil change.

NO COIL BURNOUT

Short stroke, pilot operation and a generous power margin prevent overheating, overloading and the resultant coil burnout.

Write for Catalog 6-C

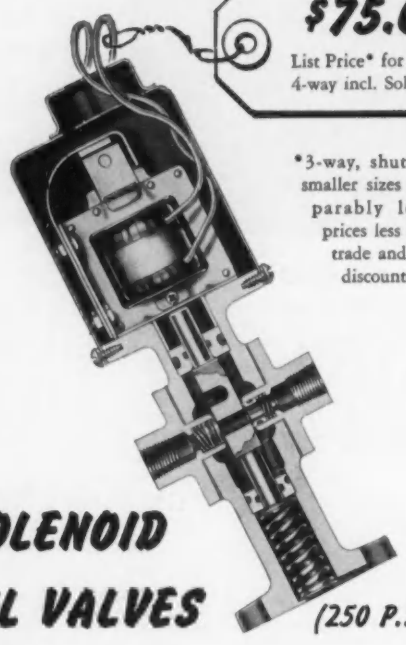
BARKSDALE VALVES

5125 Alcoa Avenue, Los Angeles 58, California

LEAKPROOF (SHEAR-SEAL)

$75.00

List Price* for a ½" 4-way incl. Solenoid



*3-way, shut-off and smaller sizes are comparably less. All prices less the usual trade and quantity discounts.

SOLENOID OIL VALVES (250 P.S.I.)

WHERE	WHY	HOW
Thread rolling machines	Holding position (leakproof)	Lapped sealing surfaces seal tight indefinitely as a result of wear compensation
Pressure testing in automotive production	Oil gets contaminated by scale in castings (not critical to dirt) reduced maintenance	Sealing surfaces in constant, intimate contact, dirt can't lock valving members – saves coil burn-out
Hydraulic work feed apparatus	(Leakproof) . . . as versus spool valves which cause overdemand on hydraulic system	Positive shut off of internal port to port leakage and of course, no external leakage
Machine tool chucking & clamping	Maintaining safe holding pressure (leakproof)	Saving auxiliary equipment such as pilot operated check valves
Automatic door openers	Quick action (high flow capacity)	No spools or poppets obstructing full, round flow passages
Solenoid controlled hydraulic system on machine you build	Better performance Lower manufacturing costs Reduce service problems	Shear-Seal valves have full flow, are leakproof, not sensitive to dirt Low priced, less auxiliary equipment and labor cost. Valves don't stick, saving coil burn-out; stay leakproof indefinitely, seals are wear compensating

BARKSDALE VALVES

5125 Alcoa Avenue, Los Angeles 58, California

Ask for bulletin 5S-H

closed circuit conditions, and in the presence of strong opposing fields. The Ceramagnets cannot be demagnetized by another magnet of a force up to 2000 gauss. The magnets are available in any size or shape, are machinable by wet grinding, and may be machined after magnetizing. The new magnets can be magnetized in any direction, but it is reported that the highest energy product is obtained by magnetizing across thinner sections.

HIGH PURITY TITANIUM FROM SCRAP METAL . . . .

. . . . is being investigated with an electro-refining method developed by the U. S. Bureau of Mines, Washington, D. C. If found to be successful, it will reduce the cost of titanium, making it available for wider use. With electro-refining, various grades of scrap, impure sponge metals, and titanium alloys can be fed into the electrolytic cell, to be deposited as a pure metal on the cathode plate. The Bureau reports that 70 per cent of the metal produced this way is premium grade, and some of it contains fewer impurities than the best pure titanium produced commercially, which is by the iodide process and costs more than $100 a pound.

OCTANE ADDED AT THE GASOLINE PUMP . . . .

. . . . gives the motorist a pick of five different grades of gasoline, ranging from regular up to 100 octane. The innovation is being tested by the Sun Oil Co. with its Blue Sunoco fuel because of the difference of at least 10 octane numbers between the needs of the lowest and the highest compression engines. The new pump used in this arrangement draws both gasoline and a special octane concentrate from two tanks. The two fluids flow through separate hoses, one inside the other, to the nozzle, where they are blended before entering the automobile tank. The concentrate is a mixture of a small number of selected hydrocarbons, blended with stocks from a Sun Oil process, and combined with tetraethyl lead. At the same time that the proper proportion of gasoline and concentrate is locked in, the correct price is set, and computed automatically as on present pumps. The setup takes part of the blending process away from the refiner.

AUTOMATIC DRY-PROCESS ENLARGER . . . .

. . . . for Filmsort microfilm cards and 35 mm microfilm rolls will reproduce fifteen 17 x 22 in. engineering drawings a minute from microfilm originals. Designer is the Radio Corp. of America, 30 Rockefeller Plaza, New York 20, N. Y., who announced that the first model is scheduled for delivery to the Overhaul and Repair Dept. of the U. S. Naval Air Station, Alameda, Calif. The new system uses the RCA developed Electrofax dry-photographic process. The enlarger-printer can be loaded with up to 500 filmsort microfilm cards, or standard 100 ft reels of 35 mm positive microfilm. The cards or roll film are fed into the lens system at the rate of one frame every 4 seconds. The paper is coated with an electrosensitive material and is electrostatically sensitized as it is processed in the machine. After being exposed to the microfilm, the latent image is developed by passing magnetic brushes across the exposed paper. The brushes consist of iron fillings mixed with a pigmented resin powder carrying a positive charge. This powder adheres to the negatively charged areas of the exposure. The developed image is fixed to the paper as it passes through a dry temperature "bath." Up to 24 multiple copies of each drawing can be produced. Cost is $85,000.

(*Continued on page 9*)

When you want the best technical assistance "on your team," *use Bonderite under the paint*

Parker technical representatives average 12 years on the job.

The Parker technical representative who lives in and covers your area has a solid background of experience—an average of 12 years on the job!

● Many people tell us this is one of the most important things we have to sell, even though it doesn't cost our customers a red cent.

It's the knowledge and experience our organization has built since the introduction in 1929 of Bonderite, the first corrosion resistant paint base. It's the competence and practical understanding of our technical representatives. It's the cooperative attitude of our Customer Service people. It's the initiative and ability of our Research staff.

When you use Bonderite on your product, all these people go on your team to see that you get best results with greatest economy.

Want these good men on your side? Write Parker today!

**Bonderite, Bonderlube, Parco, Parco Lubrite, Parker Pre-Namel—Reg. U.S. Pat. Off.*

PARKER RUST PROOF COMPANY
2179 E. MILWAUKEE, DETROIT 11, MICHIGAN

Since 1914—leader in the field

BONDERITE	BONDERITE and BONDERLUBE	PARCO COMPOUND	PARCO LUBRITE	TROPICAL
corrosion resistant paint base	aids in cold forming of metals	rust resistant	wear resistant for friction surfaces	heavy duty maintenance paints since 1883

Developments to Watch

PURE CHROMIUM BY ELECTROLYSIS . . . .

. . . . of chromic acid has been produced by the Aeronautical Research Lab., Research & Development Branch, Dept. of Supply, Melbourne, Australia. The chromium is 99.94 per cent pure, and was found to contain 0.02 per cent O_2, 0.0025 per cent N_2 and 0.009 percent H_2, as well as traces of copper, silver, magnesium boron, calcium, and sulphur. The chromium was found to be ductile at normal temperatures. This requires that the nitrogen in the surface layers be kept at a low value, otherwise chromium gets brittle. Ductile chromium is extruded and rolled, but final working should be below the recrystallation temperature.

POWDER CUTTING NOT LIMITED TO STAINLESS STEELS . . . .

. . . . as the British Oxygen Gases, Ltd., develop it for use on various steels, nickel alloys, copper, bronze, aluminum, and certain ceramics. Introduced in England in 1947, the powder cutting method is a finely divided iron powder which must be fed to the nozzle at a constant rate to insure a good cut. The powder is drawn into a stream of preheated oxygen. The combustion of the iron powder in the oxygen stream raises the temperature of the reaction and increases the fluidity of the refractory oxides, which are removed by a combined melting and fluxing action as well as by the eroding action of the iron powder. This exposes a clean surface of metal to attack, and the cut continues through the metal.

A STRAIN GAGE BALANCE . . . .

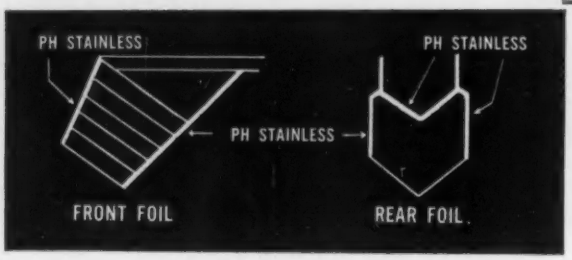
. . . . with a built-in temperature control has been developed at the U. S. Naval Ordnance Lab., Silver Springs, Md., in order to accurately measure the acrodynamic forces and movements on wind tunnel models under investigation in the hypersonic tunnel. Air speeds reach up to mach 10 in the hypersonic wind tunnel, and the supply air must be preheated to prevent air liquidification in the tunnel test section. This preheating results in temperatures as high as 1000 F on the model, and causes the phenol-resin agent that cements the strain gages to the balance to flow or creep. The cooling water system used in the new balance keeps the temperature of the strain gages at about 68 F. Under typical conditions water flows at a rate of 0.45 gpm.

AND IN ADDITION . . . .

. . . . Production of stainless and heat resisting steels in 1955 had an increase of 40 per cent over the previous year—an all time high; 1,191,177 net ingot tons compared to 852,021 tons for 1954 . . . . The Steel Founders Society is spending $100,000 in a search for a new inorganic bonding material to take the place of clay . . . . Navy Bureau of Ordnance has developed a new ultrasonic control system for torpedoes in which transistors will completely replace the vacuum tubes formerly used; control system uses the sound waves in the water to guide the torpedo to its target . . . . Low cost, high speed, 700 shots per hr, die casting machine will handle shot capacities up to 2½ lb; designed by American Die Casting Machinery Co., 1516 W. Thomas St., Chicago 22, Ill., its other features are 80 ton locking pressure, 17¾ in. square platens, 6½ in. die stroke . . . . N. V. Chemische Fabriek, Lange Haven, Schiedam, Netherlands, has a new soldering alloy with a melting point of 440 F for joining aluminum and its alloys to copper and brass; it has no lead, tin, of bismuth, is corrosion resistant, and is said to have stronger joints than those obtained with tin-based solders.

SPECIAL ARMCO STAINLESS STEEL

Helps Navy Sailboat "FLY"



▲ Skimming over the water is easy for the Navy's Monitor because its hydrofoils act like wings. As the boat picks up speed, water moving past the foils creates lift (like air passing an aircraft wing). Soon the hull is lifted above the water and the craft is free of the "hull drag barrier" which previously limited sailing speeds.

◀ Armco precipitation-hardening stainless steel bars were profile-milled to form side support struts of the large front foils, sides and upper "V" of the rear foil.

Sturdy support struts made of special Armco precipitation-hardening stainless steel bars frame the three hydrofoils of the Navy's Monitor—a "flying sailboat." These struts must be extra strong, for when the boat is "flying," all loads are carried through the stainless steel struts to the water.

Extremely high strength of Armco PH Stainless Steel bar helps the Monitor "fly" because it permits use of a thin section, reducing drag and keeping weight at a minimum. What's more, struts made of this special precipitation-hardening stainless steel offer good corrosion resistance.

Two Grades—The two Armco precipitation-hardening stainless grades, 17-7 PH and 17-4 PH, have solved product-problems for many manufacturers. They offer an unexcelled combination: Good forming and welding qualities in the annealed condition; after fabricating, high strength and hardness with low-temperature heat treatments.

Armco 17-7 PH is produced in sheets, strip, plates, bars and wire. Armco 17-4 PH is supplied in bars and wire.

For full information on these special stainless grades, call the nearest Armco Sales Office or fill in and mail the coupon.

ARMCO STEEL CORPORATION
1086 Curtis Street, Middletown, Ohio

Send me complete data on
☐ Armco 17-7 PH ☐ Armco 17-4 PH

We manufacture_____

Name_____

Firm_____

Street_____

City_____ Zone____ State_____

ARMCO STEEL CORPORATION

1086 CURTIS STREET, MIDDLETOWN, OHIO

ARMCO®

SHEFFIELD STEEL DIVISION • ARMCO DRAINAGE & METAL PRODUCTS, INC. • THE ARMCO INTERNATIONAL CORPORATION

look to Stemco Thermostats first

for precise, sensitive temperature control

If your product requires precise, sensitive temperature control . . . if it's scheduled for volume production—look to Stemco thermostats first. Since Stevens produces the broadest range of bimetal thermostats in the industry, chances are you can use a standard production-line unit to satisfy all your special requirements exactly. This saves design, development and tooling expense . . . cuts down on lead time . . . gives you a better, proven thermostat at lower cost—sooner.

1 **TYPE S** Adjustable. Positive-acting, with electrically independent bimetal. Adjusting stem and terminals to customer specification. See Bulletin F-2006.

2 **TYPE S** Non-Adjustable. Electrically identical to adjustable Type S. Single-stud mounting. Operates to 650°F. Rating: 15 amps at 115 volts AC, 10 amps at 230 volts AC. See Bulletin F-2006.

3 **TYPE SA** Adjustable. Snap-acting with electrically independent bimetal. Also single-pole, double-throw. Adjusting stem and terminals to customer order. See Bulletin L-6397-A.

4 **TYPE SA** Non-Adjustable. Is electrically identical to adjustable Type SA. Non-inductive-load rating 15 amps at 115 volts AC, 10 amps at 230 volts AC. See Bulletin L-6397-A.

5 **TYPE SM** Manual Reset. Mechanically and electrically same as adjustable and non-adjustable Type SA except for manual reset feature. See Bulletin L-6397-A.

6 **TYPE W.** Adjustable *(shown)* or non-adjustable types. Snap action prevents arcing. Operation to 350°F. Rated at 12 amps at 115 volts AC, 8 amps at 230 volts AC. See Bulletin L-6395.

7 **TYPE A** Semi-Enclosed. Insulated, electrically independent bimetal disc gives fast response and quick, snap-action control. Operation from -40° to 400°F. Various mountings and terminals. See Bulletin L-9070.

8 **TYPE A** Hermetically Sealed. Electrically identical to semi-enclosed Type A. Rated at 8 amps at 115 volts AC, 4 amps at 230 volts AC, and 4 amps at 28 volts DC. For appliance, electronic, apparatus applications. See Bulletin L-9070.

9 **TYPE C** Semi-Enclosed. Small, positive-acting. Electrically independent bimetal strip for operation from -75° to 300°F. Terminals and mountings to customer specifications. See Bulletin L-6934.

10 **TYPE C** Hermetically Sealed. Electrically identical to semi-enclosed Type C but sealed in crystal can. Also supplied as double thermostat "alarm" type. Rated at approximately 3 amps, depending on application. See Bulletin L-6934.

11 **TYPE B.** Sealed, non-adjustable *(shown)* or adjustable styles. Positive acting for operation to 650°F. Rated at 15 amps at 115 volts AC, 10 amps at 230 volts AC. See Bulletin F-2003.

12 **TYPE M** Semi-Enclosed. Compact unit with electrically independent bimetal disc for appliance and electronic applications from -60° to 400°F. Virtually any type terminal. See Bulletin F-2009.

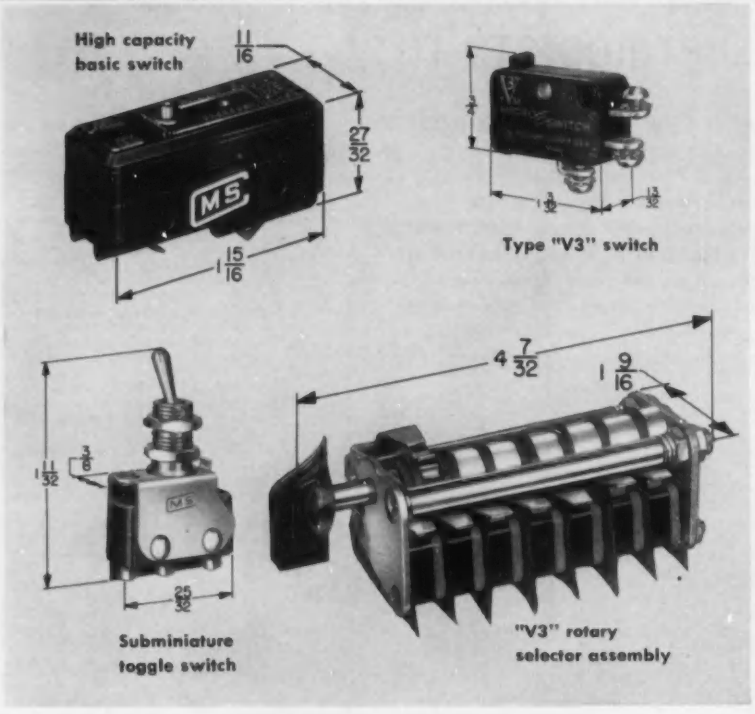
13 **TYPE M** Hermetically Sealed. Electrically same as semi-enclosed Type M. Rating: 8 amps at 115 volts AC, 4 amps at 230 volts AC, 4 amps at 28 volts DC. See Bulletin F-2009.

STEVENS manufacturing company, inc.
Lexington and Mansfield, Ohio

THERMOSTATS

MICRO precision switches

...THEIR USE IS A PRINCIPLE OF GOOD DESIGN



A continuous flow of Precision Switch developments anticipates designer's needs

Whatever the design requirement—whether it calls for unusually small size, unusually high electrical capacity or unusual actuation and circuit arrangement—there is a MICRO precision switch to meet it. That is why designers have long made it standard policy to check with MICRO SWITCH as new needs develop.

Shown here are just a few small, compact switch designs that are typical of MICRO SWITCH development. Each is one of a whole "family" of extremely reliable switches.

Type "V3" Switch. The MICRO SWITCH "V3" line switches have the highest electrical capacity for their size of any switch available. They have been developed to meet the exacting requirements of designers for an extremely small, compact switch without sacrifice of quality. Actuators are available to permit their actuation by cams, slides and other mechanical motion not in line with the switch plunger motion. (Send for catalog 74).

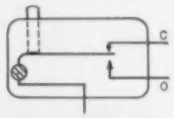
"V3" Rotary Selector Assembly. These assemblies are available with from one to eight switching units and from two to eight detent positions. Light in weight and small in size, these assemblies are well suited for use in electronic and aircraft applications. Many assemblies are available with various camming sequences. (Send for catalog 74).

High Capacity Basic Switch. This switch combines high electrical rating with high inrush capacity. The steady state current rating is 20 amperes, with inrush capacity of 75 amperes on voltages up to 460 volts a-c. These switches are especially useful for handling high inrush currents of solenoids, motors and tungsten lamps. (Send for catalog 62).

Subminiature Toggle Switch. This is one of a number of subminiature toggle switch designs developed for subminiature assemblies. The toggle switch illustrated consists of one MICRO subminiature switch riveted into the stainless steel toggle bracket. The assembly is for single-pole, double-throw service. Double-throw switches can be used "normally open" or "normally closed" by wiring to either the normally open or normally closed terminals. (Send for catalog 75).

Circuit Arrangements

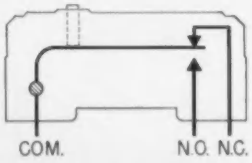
DOUBLE THROW



Type V3 Switch

This switch has a single-pole, double-throw contact arrangement. Electrical rating is: 10 amperes, 125 or 250 volts a-c; ½ ampere, 125 volts d-c; ¼ ampere, 250 volts d-c.

DOUBLE THROW

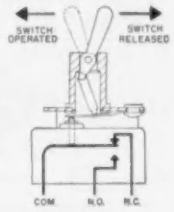


High Capacity Basic Switch

Standard switches are single-pole, double-throw. Electrical rating is: 20 amperes 125, 250 or 460 volts a-c; ½ ampere 125 volts d-c; ¼ ampere 250 volts d-c; 1 H. P. 115 volts a-c; 2 H. P. 230 volts a-c; 10 amperes 125 volts when controlling tungsten filament lamp loads on a-c circuits.

Subminiature Toggle Switch

Contact arrangement is single-pole, double-throw. Double-pole, double-throw assembly, using two subminiature switches is available. Electrical rating is: 5 amperes 125 or 250 volts a-c. The 30 volt d-c rating is, inductive—3 amperes at sea level and 2.5 amperes at 50,000 feet, resistive—4 amperes at sea level and 4 amperes at 50,000 feet, maximum inrush is 15 amperes.



MICRO SWITCH *Engineering Service, experienced in precision switching problems, is available—at the* MICRO SWITCH *branch nearest you. Why not call today?*

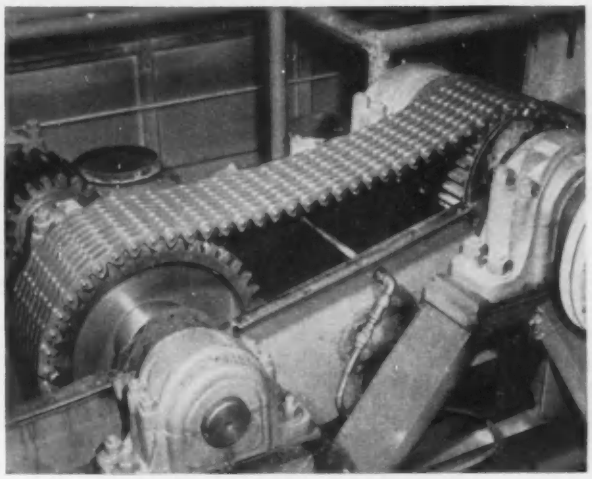
MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

In Canada, Leaside, Toronto 17, Ontario • FREEPORT, ILLINOIS

Why the design engineer is ahead when specifying

LINK-BELT Silent Chain

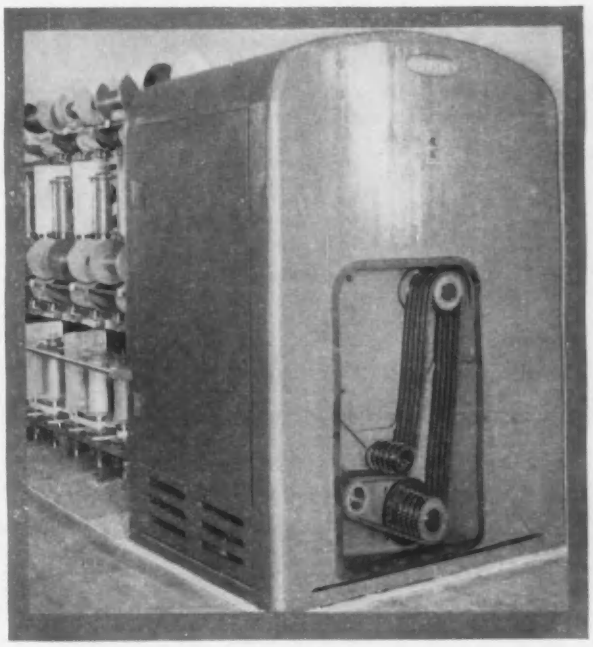


Silent chain driving from a 200-hp, 1200-rpm motor handles comfortably the extreme peak loads of draw bench service.

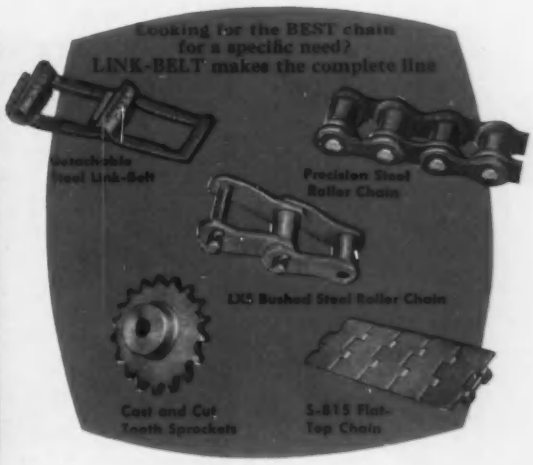
No other drive does so many jobs so well

In applications involving the transmission of fractional or thousands of horsepower, high rotative or linear speeds—no other drive can match the effectiveness of Link-Belt silent chain.

You are assured of better than 98% sustained efficiency throughout its long life. It is often lower in first cost and always lower in ultimate cost—frequently runs for 20 to 30 years with only routine attention. Get the full story on Link-Belt silent chain. Write for Book 2425, or call your nearby Link-Belt office.



Uptwister uses duplex silent chain. Note the simplicity of this drive operating multiple shafts in a textile mill.


Looking for the BEST chain for a specific need?
LINK-BELT makes the complete line
Precision Steel Roller Chain
Cast and Cut Tooth Sprockets
S-815 Flat-Top Chain

LINK-BELT

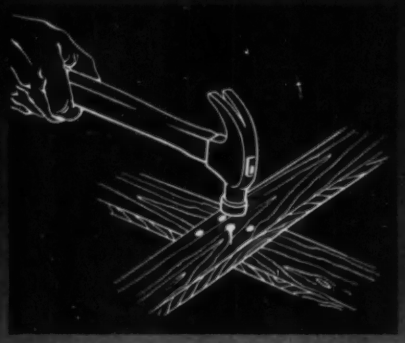
CHAINS AND SPROCKETS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

13,935

RIVETING

as easy as driving a nail!



Southco Drive Rivet Fastening . . . in blind or access applications . . . is quick and economical. One man, with only a hammer, does the job. Just hit the pin . . . the rivet's in. No other operations are needed . . . no bucking up . . . no finishing off . . . no special tools. Time and labor savings are substantial.

Parts are forced tightly together by the rivet's powerful "pull-up".

Spot the fastening applications in your production line that can benefit by the use of Southco Drive Rivets. Let a Southco engineer figure the time that can be saved. There's no obligation. Write for complete information to Southco Division, South Chester Corporation, 236 Industrial Highway, Lester, Pa.

Pat. No. 2,640,618 other pats. pending, Rivet and Mfg.

© 1954

SOUTHCO

FASTENERS

PAWL • SCREW AND SPRING • DRIVE RIVETS • ANCHOR NUTS • ENGINEERED SPECIALTIES

OFFICES IN PRINCIPAL CITIES

Forms metal by new cold flowing process–TIMKEN® bearings assure wall thickness within ±.002"

FLOTURN, a radically new metal-working process developed by Lodge & Shipley, applies continuous pressure to a metal blank, forming it to the shape of a mandrel. It's an extremely accurate process. Even under heavy loads at high speeds, this L & S No. 40 FLOTURN Lathe holds wall thickness tolerances to ±.002".

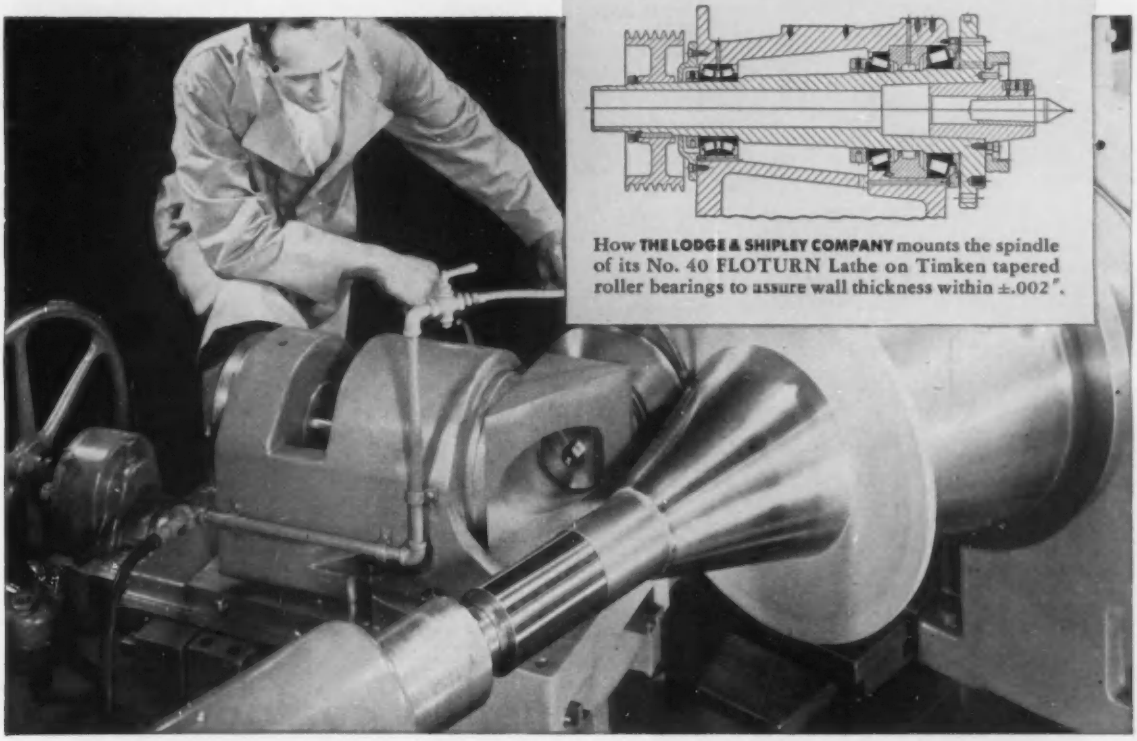
One big reason for this accuracy is the Timken® tapered roller bearings on the spindle. The tapered construction of Timken bearings lets them take the heavy radial and thrust loads in any combination—holds the spindle in rigid alignment. And line contact between the rollers and races of Timken bearings gives them extra load-carrying capacity — important since the metal is shaped by very high pressures.

Timken bearings practically eliminate friction, saving power. The geometrically correct design of Timken bearings gives them true rolling motion; their accuracy lives up to that design.

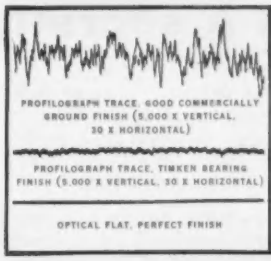
Under normal usage, Timken bearings last the life of the machine tool. One reason is that they're made of Timken fine alloy steel. We have to make the steel ourselves, because that's the only way we can completely control quality. We're the only American manufacturer that does.

Whatever machine tool you build or buy, be sure it's equipped with Timken tapered roller bearings. Always look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



How **THE LODGE & SHIPLEY COMPANY** mounts the spindle of its No. 40 FLOTURN Lathe on Timken tapered roller bearings to assure wall thickness within ±.002".


PROFILOGRAPH TRACE, GOOD COMMERCIALLY GROUND FINISH (5,000 X VERTICAL, 30 X HORIZONTAL)
PROFILOGRAPH TRACE, TIMKEN BEARING FINISH (5,000 X VERTICAL, 30 X HORIZONTAL)
OPTICAL FLAT, PERFECT FINISH

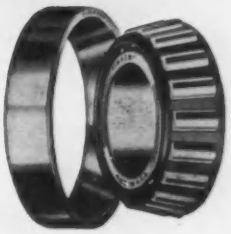
SMOOTH TO MILLIONTHS OF AN INCH

Surface finish of high quality Timken bearing rollers and races is so smooth that it takes a profilograph to measure its smoothness. This instrument measures surface variations to a millionth of an inch, as shown at the left.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ▯ AND THRUST ⊣▯⊢ LOADS OR ANY COMBINATION ✳

satisfied customers don't keep it a secret!

This man's bought a new way to do an old job . . . an electric power mower to cut his lawn. It's powered by a Packard Electric motor, in fact, and he's letting his neighbor in on its smooth, quiet, dependable performance. No, there's no secret here. There seldom is when an appliance is Packard-powered!

Packard Electric is an old hand at building satisfaction into motors. For over 39 years, Packard fractional horsepower electric motors have been delivering the kind of performance that makes for scenes like this. And scenes like this can't miss building sales and goodwill for appliance manufacturers.

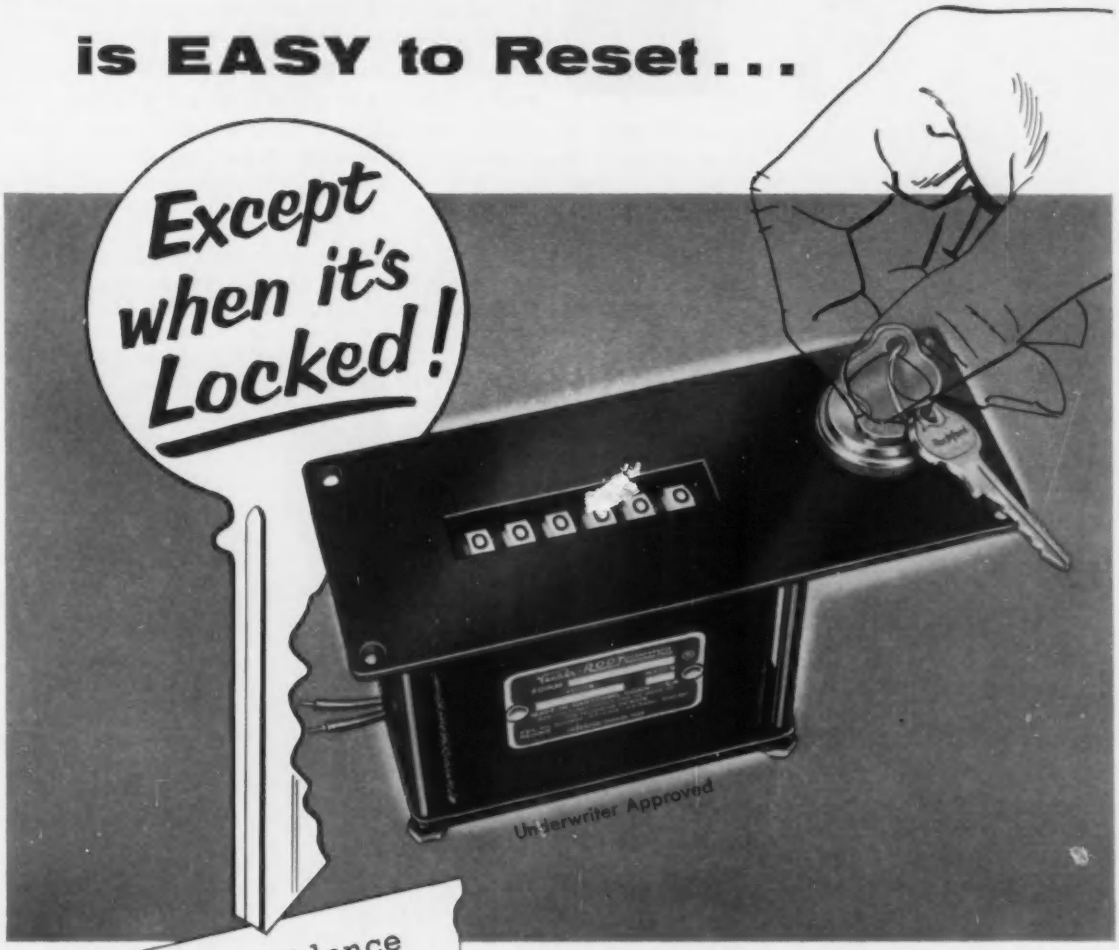
GM GENERAL MOTORS

Packard

REG. U.S. PAT. OFF. TRADE MARK

Packard Electric Division
General Motors, Warren, Ohio

This NEW Magnetic Counter is EASY to Reset...



Added Evidence that—

Everyone Can Count on VEEDER-ROOT

Designed for panel mounting where remote indication is required, this electrically operated counter is a compact package 5.5″ long, 2.1″ wide, 2.7″ high. Capacity: 1,000 counts per minute. Power consumption, 8 watts. Stocked in 110 and 220 AC and DC. Easy to reset, except when locked . . . then the sturdy tumbler-lock* puts the damper on tampering. Yet one turn of the key resets all 6 figures to zeros.

This new Magnetic Counter is one of the thousands of Veeder-Root standard and special counters . . . electrically, mechanically and manually operated . . . in daily use throughout the world in industry, business, science and medicine. You, too, can count on Veeder-Root . . . to help you count anything you need.

*National Lock Co. Lock No. 68-4837; Key D-428

Stocked at
Hartford 2, Conn. • New York 19, N. Y.
Greenville, S. C. • Chicago 6, Ill.
Montreal 2, Canada
Offices and Agents in Principal Cities

VEEDER-ROOT
"THE NAME THAT COUNTS"

Craftsmanship of the 20th Century

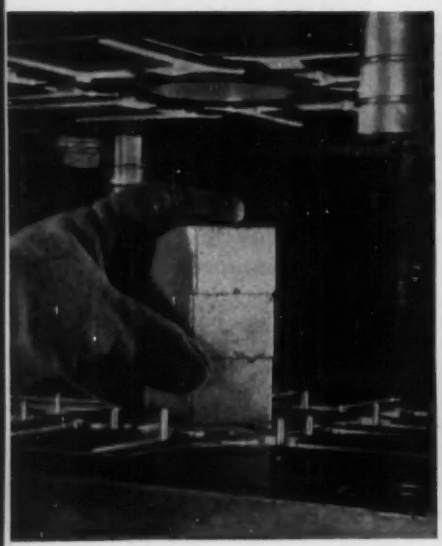
MONSANTO

Feverish competition in today's giftware market gives industrial designers many a sleepless night. Forever foremost is the challenge to be first with something new, something better. Read how, by working closely with plastics engineers in the custom molding industry, one of America's leading manufacturers pioneered a winner which utilizes the unique properties offered by plastic materials.

How handles of Resinox phenolic plastic are high-styling Inland Carafes

DESIGN OBJECTIVES. To restyle the conventional coffee carafe with a handle that would both enhance the beauty of the unit and facilitate its pouring. When the Inland Glass Works Division of the Club Aluminum Products Company gave the project to its designers, they were instructed to keep appearance and functionalism uppermost in their plans. Moderate cost was a secondary, but important, consideration.

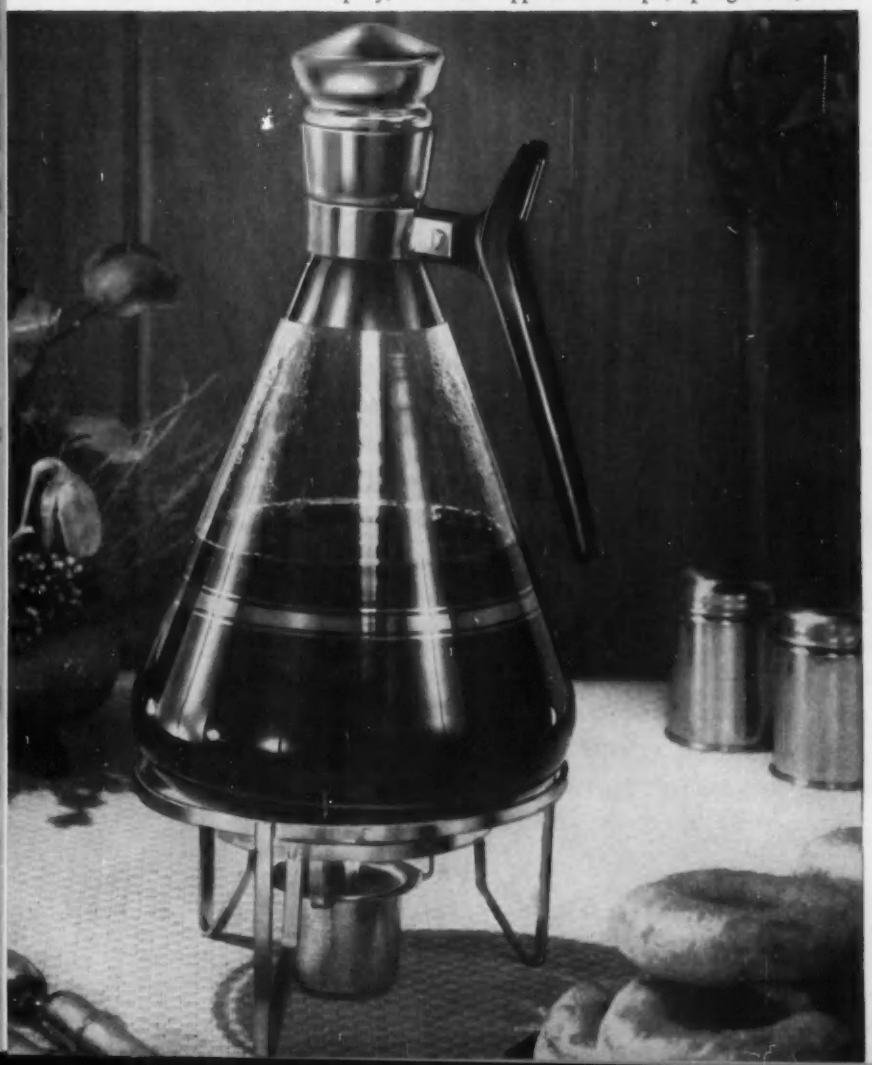
MATERIAL SPECIFICATION. Designs dictated that the handle be riveted to a 1-inch metal band at the neck of a cone-shaped bottle. Because the center of gravity was extremely low (far below the fulcrum of the handle), a material of outstanding strength was required. Steel was rejected—its high heat absorption made the handle uncomfortable to hold. Wood was rejected—it has a tendency to split with the grain and demanded an additional, expensive finishing step. Selection was narrowed down to a phenolic plastic. This material is both flame- and heat-resistant, has the moldability, inherent color and surface smoothness to permit optimum flexibility in design. (Inland Glass had long been using phenolic plastics with great success on other giftware items.)



PRODUCTION ENGINEERING. The custom molding job was awarded to Ackerman Plastic Molding Company, Div. Consolidated Iron-Steel Manufacturing Company of Cleveland, Ohio, whose engineers specified Monsanto's Resinox 1004—a phenol-formaldehyde high-luster plastic with a superior impact strength of .34 foot pounds per inch. The fast flow and curing properties of Resinox 1004 permit non-critical transfer molding at 325° F. Molding powder is preformed into "pills," heated in an electronic oven and placed in the plunger mold. After a 70-second cycle, the "shot" containing 12 molded handles is removed and separated from the runners. The surface of the molded handles has been consistently mirror-smooth. Another vital property of Resinox 1004 compound is strength to resist cracking when metal rivets are inserted into molded-in handle holes and expanded to grip the plastic handle to the metal neck sleeve.

THE FINISHED PRODUCT. Elite Carafes are now smartly serving coffee in more than 800,000 homes. The jet black handles which gracefully parallel the contours of the flask need no finish. Their ebon beauty will never peel or chip—and accentuates the decorative stripings in copper and platinum. Styling like this has made Inland Glass one of the leaders in its field.

This is one of hundreds of design and production problems which have been solved by utilizing the facilities of the plastics custom molding industry. These 20th Century craftsmen are available to manufacturers designing for greater efficiency and lower costs. As a major supplier of plastic resins, Monsanto is in a position to introduce you to custom molders who will put their skills to work for you. If you are considering a design change for your product line, be sure to investigate plastics. Write to Monsanto Chemical Company, Industrial Applications Dept., Springfield 2, Mass.



Investigate Monsanto's completely balanced line of phenolic plastic compounds developed for particular applications and sold under the trade name . . .

RESINOX®

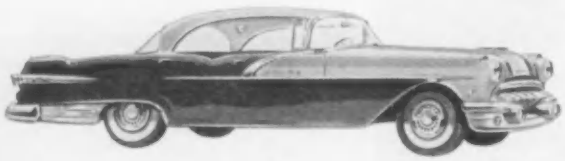
MONSANTO

WHY PONTIAC SWITCHED SHELL-CAST CRANKSHAFTS

For many years automotive engineers have sought to produce a successful *cast crankshaft*. But either the material or the method of casting did not give the desired results. Now, however, Central Foundry Division has solved both problems by means of their tough pearlitic malleable iron, ARMASTEEL, and their perfected shell molding process. Pontiac Motor Division is the first of the great automobile manufacturers to capitalize on the advantages of the new ARMASTEEL crankshafts. After conducting a long and exhaustive series of tests in the laboratory and on the road, Pontiac is now installing shell-cast ArmaSteel crankshafts in all 1956 models.

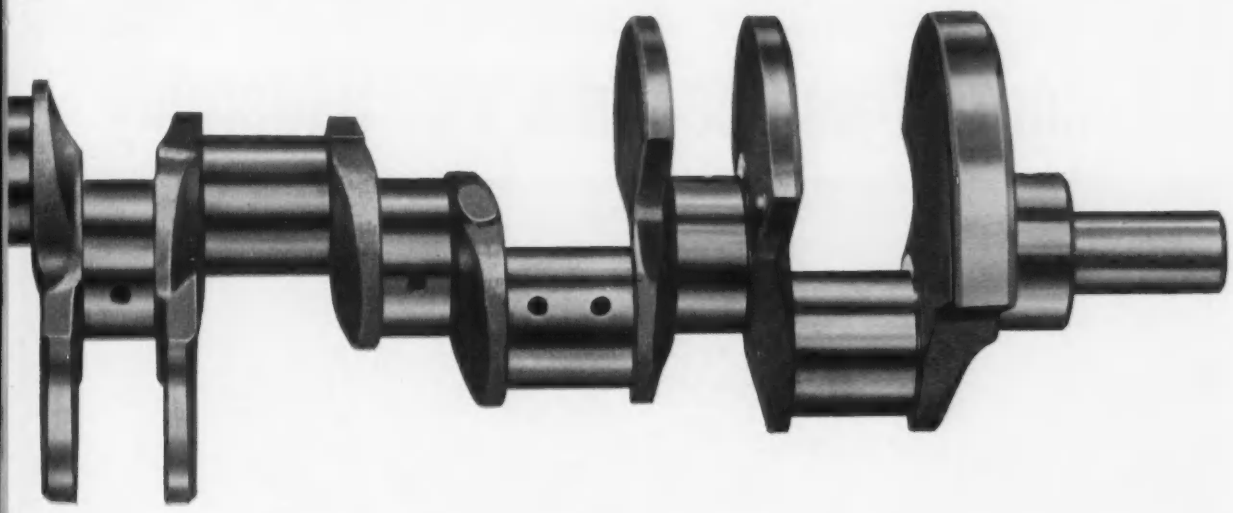
ARMASTEEL, the metal, is a triumph of modern metallurgy that combines the advantages of both castings and forgings. Its resistance to fatigue and wear assures long life. Its rigidity results in minimum deflection and accurate alignment. Its high damping capacity allows it to absorb vibrant energy and thus contribute to noiseless operation.

The crankshaft, made by the shell-mold process at Central Foundry, results in substantial manufacturing savings. Because the castings are so close to the final finished dimensions, shell-cast ArmaSteel crankshafts are lighter and require considerably less machining and finishing.



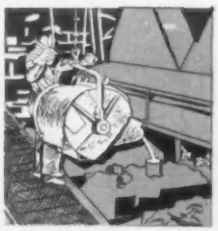
Many manufactured products can be improved and the costs lowered with shell-cast ARMASTEEL. If you are a manufacturer, engineer, production man or purchasing director, it will pay you to write us today for your copy of the book "ARMASTEEL" and the pamphlet "Shell Molding at Central Foundry".

TO ARMASTEEL

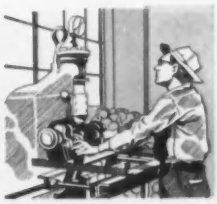


BETTER MATERIALS, BETTER METHODS, LESS MACHINING AND THOROUGH TESTING MEANS BETTER CRANKSHAFTS FOR PONTIAC

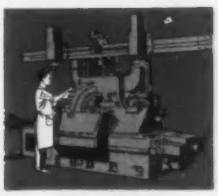
SHELL MOLDING allows metal to be poured exactly where it is needed. Tolerances can be so close that finishing can be reduced and, in some areas, eliminated. The shell mold gives the engineer considerably greater latitude in design.



ARMASTEEL is a pearlitic malleable iron with characteristics of low carbon steels produced only at Central Foundry Division of General Motors Corporation. Its machinability is rated 33⅓% better than SAE 1045 steel. It is uniform in structure, possesses excellent bearing qualities, responds readily to localized hardening, and is a material of exceptional rigidity.



MODERN TESTING techniques in the new shell-cast ARMASTEEL crankshafts include gamma-ray radiography, 100% magnetic particle inspection and sonic testing (a Central Foundry development) on each individual crankshaft.



LESS MACHINING and finishing is required with shell-cast ARMASTEEL crankshafts. Rack-to-rack lathe cycle time on in-line diameters, for example, was cut in half! Cutter and grinding wheel life is increased in all machining operations.

CENTRAL FOUNDRY DIVISION · GENERAL MOTORS CORPORATION

CENTRAL FOUNDRY DIVISION

GENERAL MOTORS CORPORATION

SAGINAW, MICHIGAN • DEPT. 10

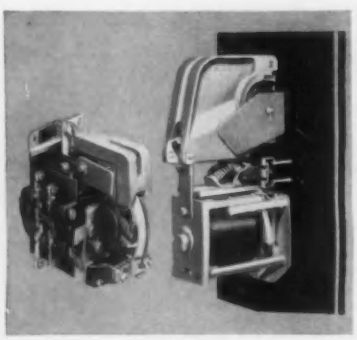
64

GENERAL ELECTRIC *Control*

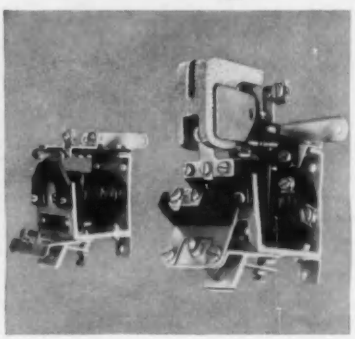
G-E control components cut assembly

GENERAL ELECTRIC CONTROL COMPONENTS ON LARGE PANELS—SUCH AS THIS STEEL MILL UNIT—HAVE RECORDS OF OUTSTANDING

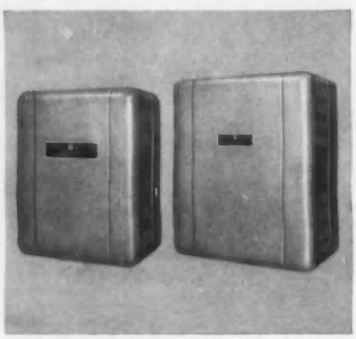
Wide Range of General Electric



LONG-LIFE CONTACTORS available in ratings from 1–2500 amperes, and can be specified mounted or unmounted.



ACCURATE RELAYS, ranging from general purpose control type to special relays, meet your own varying requirements.



DEPENDABLE DC STARTERS available in all popular NEMA sizes help give your motors complete protection.

G-E control components ranging from tiny resistors to large contactors, are available for all types of control boards.

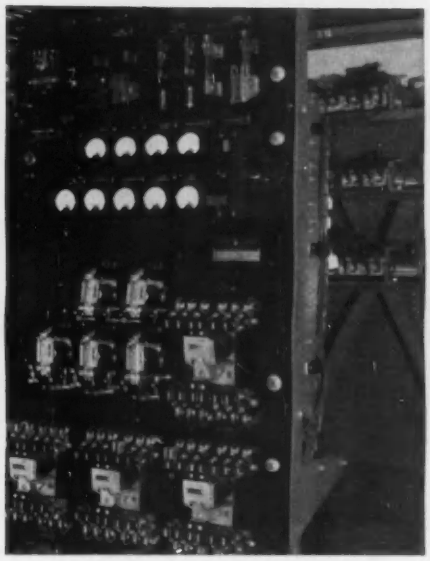
STARTERS

CONTACTORS

RELAYS

News for panel builders

time of large or small panels



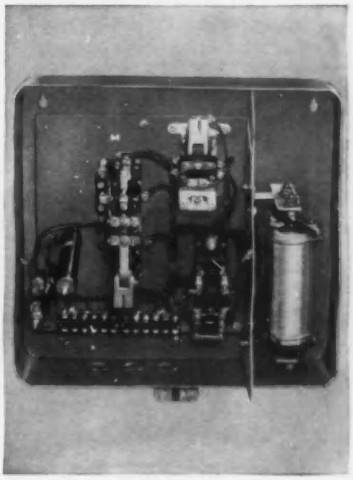
PERFORMANCE AND RELIABILITY.

Whether you build large steel mill panels or small panels for machine tools, General Electric's complete line of easy-to-install control components will help cut valuable assembly time.

G-E contactors, relays, resistors, starters, and rheostats have proven reliable in industry-wide applications. These control components are designed to give you top performance under all types of operating conditions.

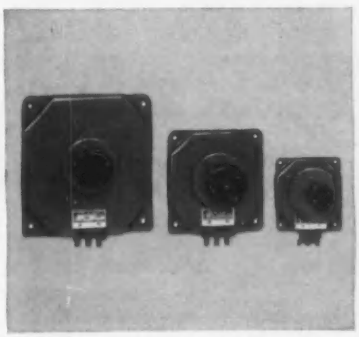
Fast delivery is another reason why you should specify G-E control components. Stocks of standard units are available from warehouses throughout the country. And, specially designed components receive particular attention at the factory.

If you have any problems concerning control components, experienced G-E engineers are available to help you select the correct components to help you meet your requirements. Contact them at your nearest G-E Apparatus Sales Office. General Electric Company, Schenectady 5, N. Y.

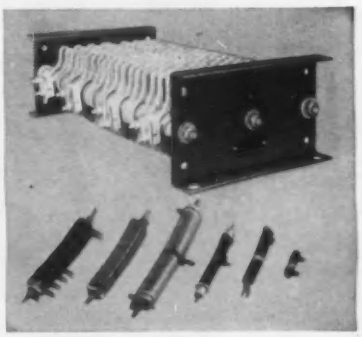


G.E.'s complete line of control components are used in large panels (left) or in small panels as shown above.

Control Components Available



RUGGED RHEOSTATS for field application are available in plate type construction for circuits up to 600 volts maximum.



RELIABLE RESISTORS in sizes ranging from 10 to 5000 watts are manufactured in single or multiple units to meet your particular need.

General Electric Company
Apparatus Sales Division
Section F 784-2
Schenectady 5, N. Y.

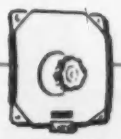
Check below for further product information.

☐ Starters ☐ Rheostats
☐ Contactors
☐ Relays ☐ Resistors

NAME.....

COMPANY.....

CITY..... STATE.....



RHEOSTATS

RESISTORS

Progress Is Our Most Important Product

GENERAL ELECTRIC

Aluminum cuts costs on three screw

$69.90 SAVED!

Three movement pillars per clock. Cost of parts for 10,000 clocks:

Brass	$120.96
Less scrap recovery	12.48
	$108.48
Aluminum	$ 40.32
Less scrap recovery	1.74
	38.58
SAVED WITH ALUMINUM	$ 69.90

$54.42 SAVED!

Two case pillars per clock. Cost of parts for 10,000 clocks:

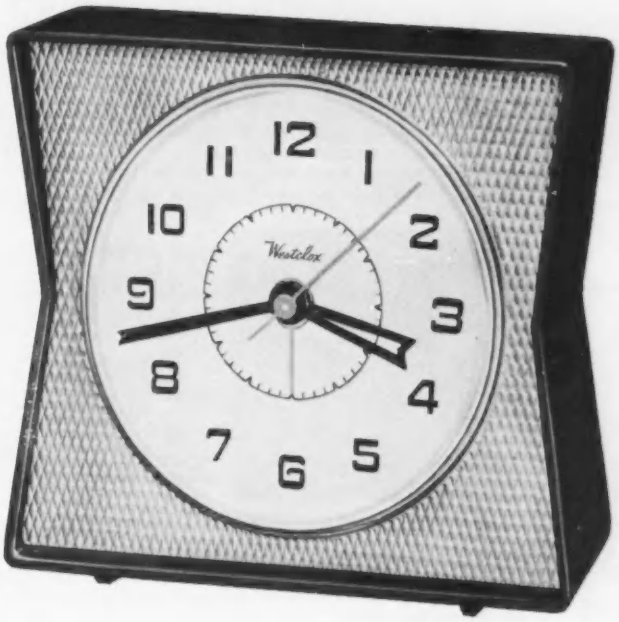
Brass	$96.00
Less scrap recovery	6.66
	$89.34
Aluminum	$35.84
Less scrap recovery	.92
	34.92
SAVED WITH ALUMINUM	$54.42

$9.08 SAVED!

One hour wheel bushing per clock. Cost of parts for 10,000 clocks:

Brass	$32.16
Less scrap recovery	12.49
	$19.67
Aluminum	$12.32
Less scrap recovery	1.73
	10.59
SAVED WITH ALUMINUM	$ 9.08

machine parts for WESTCLOX



WESTCLOX MANAGEMENT SAYS:

"We recommend that aluminum be used in all cases where it can save us money, as it does with the three parts shown here. Lower raw material costs without any sacrifice in machining time is the main reason for the savings we get with aluminum."

WESTCLOX ENGINEERING SAYS:

"In addition to its economy, we find that aluminum is often more suitable for certain parts than brass or steel."

WESTCLOX PRODUCTION SAYS:

"We find that aluminum screw machine stock machines easily and has equal or better machining rates than other metals. No special tooling or other preparation is required."

THE EXPERIENCE of Westclox, Division of General Time Corporation, is more evidence of this important fact: when you specify *aluminum* screw machine parts you often get *better* parts for *less money*.

A pound of Kaiser Aluminum screw machine stock gives you *three times* as many parts as a pound of brass or steel. And these parts provide you with a unique combination of advantages, including lightness with strength, handsome finish, corrosion resistance, good heat and electrical conductivity.

For more information or assistance, look for our local number in the classified telephone directory under the heading "Aluminum" or contact one of our many distributors. Kaiser Aluminum & Chemical Sales, Inc. *General Sales Office,* Palmolive Bldg., Chicago 11, Illinois; *Executive Office,* Kaiser Bldg., Oakland 12, California.

Kaiser Aluminum

setting the pace—in growth, quality and service

WRITE FOR VALUABLE LITERATURE!

Product catalog contains Kaiser Aluminum availabilities, specifications, alloys. See in Sweet's File for Product Designers or write for your copy to: Industrial Service Division, 6121 Kaiser Building, Oakland 12, California.

Cylindrical Roller Bearing Inner Races

Their vital importance in bearing performance . . . advantages of carburizing . . . the manufacturing procedures which assure maximum quality and life

The function of an inner race is to provide a fatigue-resistant surface between a shaft and the rollers of an anti-friction bearing. Because of the geometry of a roller bearing, there is a smaller area of contact between the inner race and rollers than there is between the outer race and rollers.

This smaller area of contact has the effect of concentrating the loads on the inner race to a greater degree. Therefore, the inner race is always the critical member of a roller bearing from a fatigue life standpoint. When the inner race is the stationary member and the outer race rotates, this load concentration on the inner race is even more of a factor since the maximum load is repeatedly applied at one point.

Adequate resistance to relative movement between the inner race and shaft is vital to satisfactory performance. HYATT inner races are made of materials chosen to permit relatively heavy press fits. When HYATT press fitting recommendations are followed, the inner race becomes an integral part of the shaft for all practical purposes.

1. WHY CARBURIZING?

HYATT inner races are made of a good *carburizing* grade of steel, rather than through-hardened steel, for several reasons. First, carburizing permits the vital heavy press fits referred to above. Second, tough flanges that will not break out under impact can be obtained on carburized races with no loss of case hardness. Third, carburizing improves load-carrying capacity, as shown in Diagram A. During quenching, the phase change from austenite to martensite which occurs in the outer case is accompanied by a volumetric change; but the low carbon core remains tough and ductile *without* appreciable volumetric change. The result is a tendency to stretch the core and compress the case. Due to the Poisson effect, *the compressive hoop stresses in the external fibres build up the load-carrying capacity of the race.*

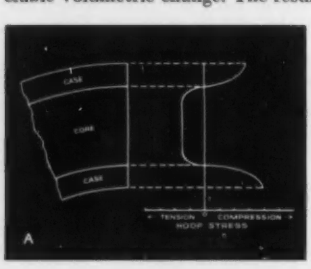
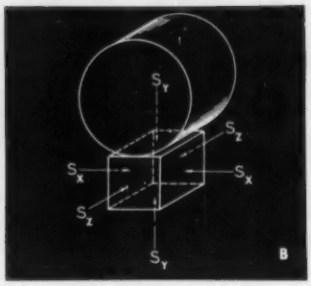


Diagram B shows a typical element of a HYATT carburized inner race under roller load. Stresses in the "Z" direction are negligible. Stresses in the "X" direction are compressive hoop stresses or preload. Stresses in the "Y" direction are compressive stresses due to the load. Without the compressive stress Sx (hoop stress) the load-carrying capacity would be less; and should the stress in the "X" direction become a tensile stress due to pressing a through-hardened race on a solid shaft, the capacity would be still further reduced. Reference to applicable theories of material failure will support this view and indicate why HYATT has gone to substantial added expense to give customers the benefits of carburized inner races.



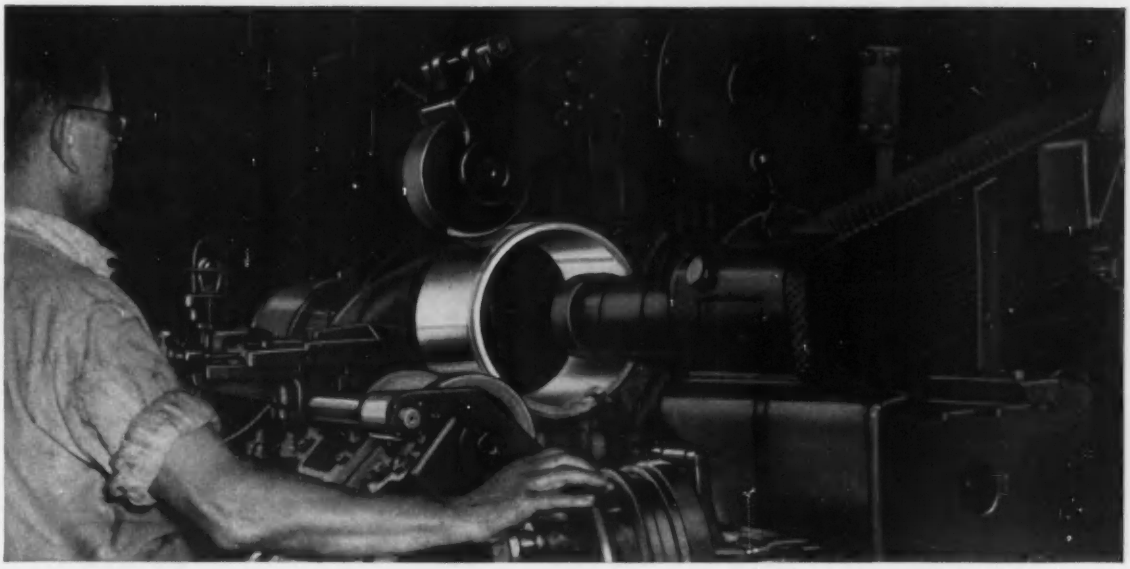
2. OPERATIONAL REQUIREMENTS

A top-quality inner race should have all the following characteristics:

1. *Minimum wall variation:* Concentricity of the inner race pathway to bore is necessary for quiet operation at full bearing capacity.
2. *Minimum runout of race ends to bore:* The bearing must not be cocked on the shaft by location against a square shoulder with a race end having excessive runout.
3. *Minimum runout of race flange inner faces to bore:* Excessive flange face runout results in noisy operation and hunting of the shaft.
4. *Minimum bore tolerance:* An important fitting consideration. If all the available tolerance is taken in the race bore, the shaft tolerance is unnecessarily restrictive.
5. *Minimum pathway and bore taper:* Taper causes uneven roller loading with resultant overheating and poor life.

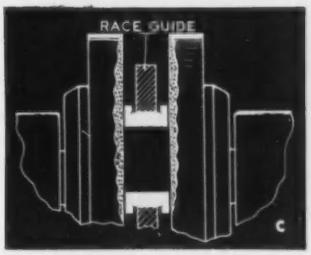
3. MANUFACTURING PROCEDURES

Good control of primary machining is reflected in good quality of the finished product. The early stages of manufacture, through the heat treating operation, are highly important and are all scrupulously controlled by HYATT. In this article, however, the *finishing operations* are of primary interest and will be discussed in detail.



Centerless grinding operation on a large Hyatt inner race.

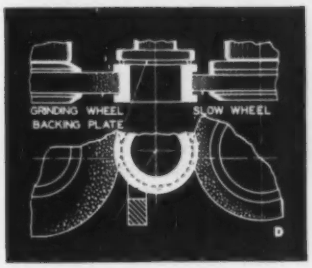
4. DOUBLE END GRIND



The sequence of grinding operations is important. The ends must first be faced off *square and parallel* so that during subsequent operations the ends can be used as accurate reference. The HYATT double end grind operation illustrated in Diagram C insures excellent control of race end parallelism.

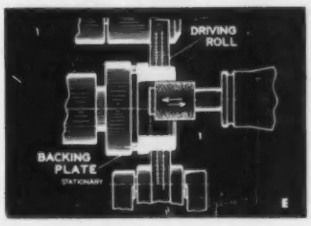
5. CENTERLESS PATHWAY GRIND

The centerless grinding principle was pioneered by HYATT many years ago. This method was a significant improvement over existing chucking methods because it eliminates excessive wall variation introduced by spindle and chucking errors.



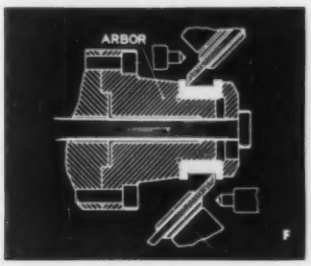
The race pathway is ground by the centerless method to produce a race with as nearly a perfectly round diameter as is commercially practical. Two-point and three-point out of round as well as taper are held to a minimum. Note that the work is rotated with a backing plate against the previously ground end, as shown in Diagram D.

6. CHUCKLESS BORE GRIND



Here again the centerless method is employed to generate an inner diameter (bore) concentric with the outer diameter (pathway.) This is accomplished by driving the race on the outer diameter and positioning the grinding wheel relative to the drive roll. The result is maintenance of minimum wall variation by removing stock from the high spots as they pass between the drive roll and the grinding wheel, as shown in Diagram E.

7. FLANGE GRINDING



All flange faces must be ground to run true with the roller pathway. Since the pathway and bore have been ground using the ends as a reference, the ends are also used as reference while grinding the flange faces (Diagram F). This establishes all-important even contact with the roller ends during operation of the bearing.

8. VIGILANT INSPECTION

Strict inspection is vital to the maintenance of high-quality standards in a precision product such as roller bearings. Working with the finest test equipment under conscientious supervision, highly trained HYATT inspection teams constantly watch the quality of HYATT parts as they are produced. This insures traditional HYATT dependability.

YOU WILL FIND FURTHER DETAILS

in HYATT General Catalog No. 150, or your nearby HYATT Sales Engineer will gladly help you choose the type of cylindrical roller bearings best suited to your design requirements. Remember, HYATT is America's *first* and *foremost* maker of roller bearings. Hyatt Bearings Division of General Motors Corporation, Harrison, New Jersey.

GM GENERAL MOTORS

HYATT

ROLLER BEARINGS

NEW KNIGHT

carries 35% extra

The roof, roof bows, side walls, side rails, reinforcements and doors of the new Volume Van are fabricated from high tensile strength stainless steel. The Van is 35′ long, 11′ high and utilizes 94″ of space out of a possible 96″ of legal outside width. Inside length is only 4½″ less than the overall length. The "Shot-weld" process of construction, developed and employed by The Budd Company in producing panels, etc., fuses the entire stainless steel structure into one integral unit.

REPUBLIC

REPUBLIC STEEL

World's Widest Range of Standard Steels

OF THE OPEN ROAD

payload in lightweight armor

of STAINLESS STEEL

It's the Fruehauf Trailer Company's new Stainless Steel Volume Van.

Stainless steel trailer construction is not new in itself. Stainless steel trailers have been used for years by both large and small fleet operators for transporting milk, meat, produce and frozen foods. They have found that the corrosion-resistant and sanitary qualities of stainless steel cannot be matched for use in refrigerated trailers.

Stainless steel trailers are also at the top of the list for carriers of salts, acids and other chemicals that attack other metals used in trailer construction.

Stainless steel's exceptionally high strength-to-weight ratio has made it possible to design this completely new trailer with 35% extra payload capacity.

Stainless steel construction permits the use of thinner, lighter sections—without loss of strength, without sacrifice in safety. Yet with long life assured at the lowest ultimate cost.

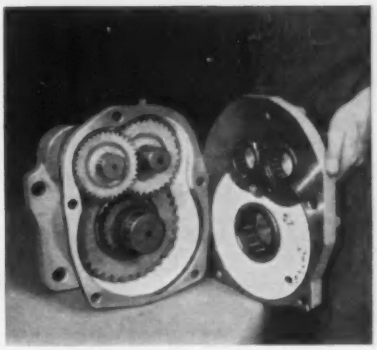
Republic—maker of ENDURO Stainless Steel and world's largest producer of alloy and stainless steels—is proud of its contribution to the new Volume Van. And we offer you the services and knowledge of our metallurgical and engineering departments in helping you use stainless steel to give your product strength without added weight or make it look better and last longer.

Just send us the coupon for more information.

Here are two more Republic products with advantages for equipment builders

NEW USES FOR REPUBLIC NYLOK NUTS are constantly being developed. In this tie-rod clamp assembly they provide positive locking and ease of adjustment. They are ideally suited for mechanical feeding and power wrenching because either end is up. Republic Nylok Nuts lock whether seated or not. Cut maintenance costs, too. They can be backed off for parts inspection or adjustment and then can be re-used.

EXTRA STRENGTH WITHOUT EXCESS WEIGHT is built into parts when you design with Republic Alloy Steels. These fine steels provide an outstanding combination of qualities essential to safety in designing equipment to carry heavier loads at higher speeds. Alloy steels lengthen service life in transmissions, bearing, shafts, axles, etc. Republic metallurgists are available to help you use these steels to the best advantage in your product.



STEEL

and Steel Products

REPUBLIC STEEL CORPORATION
Dept. C-1436
3150 East 45th Street
Cleveland 27, Ohio

Please send more information on:

☐ ENDURO® Stainless Steel Intended Use_____

☐ Nylok® Nuts ☐ Alloy Steels

® U. S. Pat. No. 2,450,694 and pending applications.

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

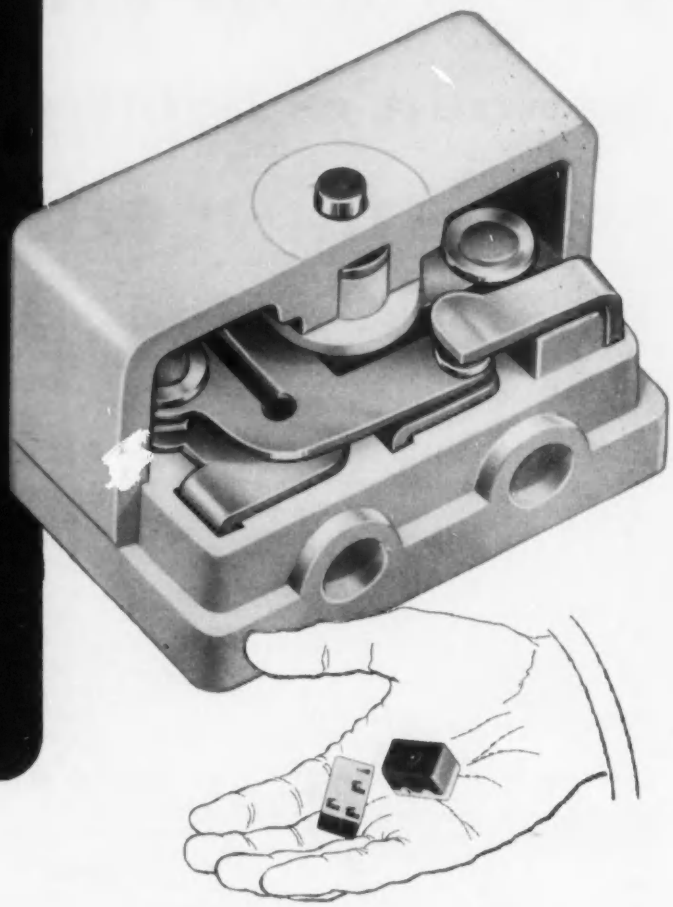
Here it is!

the New KLIXON®

Miniature

Precision Sine Switch

For Aircraft and Industrial Controls, Actuators, Relays, Instruments, etc.



CHECK THESE FEATURES:

- ***Unexcelled Shock and Vibration Resistance*** — precise operation unaffected by 10 G's . . . vibration from 0-500 cps.
- ***Small Movement Differential*** — less than .001".
- ***High Current Carrying Capacity*** — 10 amperes, 30 VDC and 115 VAC.
- ***Minimum Effect from Ambient Temperature*** — −65° and +275°F operation.
- ***Miniature Size*** — one-half size of comparable units.
- ***Long Life*** — 100,000 cycles minimum.
- Available with a variety of actuators.

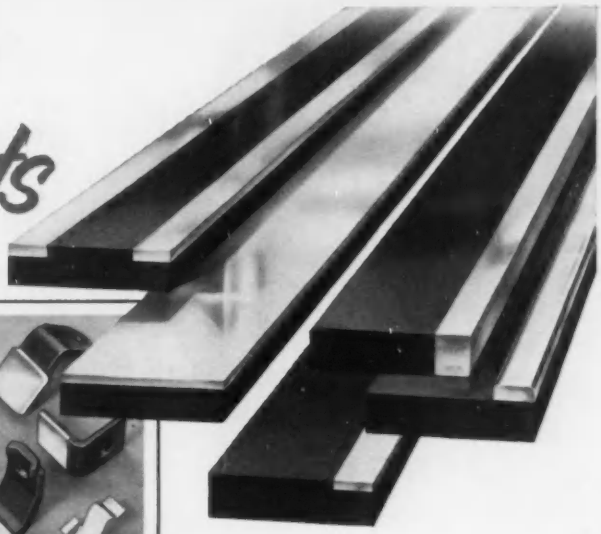
This Klixon Sine Switch (J series) is a highly precise, sensitive snap switch for applications requiring extremely small movement differential with high resistance to shock and vibration. Movement differential as well as operating and release forces can be adjusted and set to meet a wide variety of application requirements. Once calibrated, the KLIXON Sine Switch precisely maintains its operating characteristics throughout its life.

Write for Catalogue PR-1100 which gives performance characteristics on the J series and other Klixon Precision Sine Switches.

KLIXON

METALS & CONTROLS CORPORATION
SPENCER THERMOSTAT DIVISION
904 FOREST ST., ATTLEBORO, MASS.

Speaking of Cutting Costs



General Plate

COMPOSITE METAL CONTACTS

Save Money and Improve Performance, too!

That's right — time and time again General Plate Division has been able to cut electrical contact costs for customers — while improving product performance.

At General Plate Division customers with contact questions deal directly with a top notch team of Engineers, Production people, and Cost Analysts who specialize in contact activities.

Result? Savings — savings by design for alert customers — with improved performance in the bargain.

Here's what's behind it —

Drawing on forty years of metal cladding experience, General Plate Engineers have developed superior bonded metals which combine the best electrical and mechanical properties of two or more separate metals for greatest contact efficiency and economy.

General Plate Production people have developed the finest facilities available for the manufacture of all kinds of contacts from these materials.

General Plate Application Engineers and Cost Analysts have worked out contact design details which assure you contacts you can count on — at real savings.

You too can earn this double dividend at General Plate Division — why not investigate — today.

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
14 FOREST STREET, ATTLEBORO, MASS.

GENERAL PLATE ELECTRICAL CONTACT KIT FOR LABORATORY AND DEVELOPMENT USE

Kit K11 contains a wide assortment of silver rivet contacts; Kit K12 has representative standard button contacts. Also included are metal strips for fabrication of contact parts. These kits are available at nominal cost. Bulletin available.

You can profit by using General Plate Composite Metals

TEXROPE
Greatest Name in V-Belt Drive

The Only Complete Line of Variable Speed V-Belt Drives

Texrope Fixed-Speed Drives

For transmitting power efficiently between motor and load where speed variation is not required.

Texrope Grommet Belts

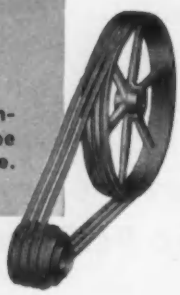
This heavy-duty construction gives from 30% to 50% longer life at no extra cost. The grommet is endless, eliminating the stiff overlap that sets up strains and causes eventual breakdown in ordinary belts. Oil-resisting and static-conducting belts also are available.

Magic-Grip Sheaves

Designed for fast, easy mounting and dismounting. You simply slip the assembled unit on the shaft, slide it to the desired position and tighten the screws which clamp the split tapered bushing on the shaft. The result is safe, smooth-running performance.

Stationary Control *Vari-Pitch* Sheave

where speed changes are infrequent and machine can be stopped to make the change.



9% to 38% Speed Variation

One *Vari-Pitch* sheave and one fixed-diameter sheave are used to get this speed variation. Here's the low-cost way of providing variable speed. No need for high-cost special motors or electrical control. Takes only a few minutes to alter pitch diameter to change speeds.

To 196% Speed Variation

Two *Vari-Pitch* sheaves — one on the driver shaft and one on the driven shaft — can greatly increase the range of speed variation. *Vari-Pitch* sheaves provide long-lasting, dependable performance, plus accurate speed control.

Motion Control *Vari-Pitch* Sheave

for applications where frequent changes must be made while drive is in motion.

Single motion-control type for speed variations to 38%. Simply turning a handwheel provides positive speed change using motion-control *Vari-Pitch* sheaves. Handwheel actuates adjusting mechanism to change sheave pitch diameter and adjust belt tension by moving motor base.

Double motion-control type for speed variations to 196%. Motion-control *Vari-Pitch* sheaves can be used on both driven and driver shafts. In this case changes in pitch diameter of motor sheave are offset by an opposite change in the driven sheave — thus maintaining constant belt tension.

Texrope, Magic-Grip and Vari-Pitch are Allis-Chalmers trademarks.

For further information ask your Allis-Chalmers Distributor or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin

ALLIS-CHALMERS

A-4845

...a message from the editors of

Product Engineering

Why We Believe You Will Benefit From Attending the First Design Engineering Show and Design Engineering Conference in Convention Hall, Philadelphia, May 14-17, 1956

The rapid pace of new product design and development demands that the engineer keep informed of the constant changes in the design field. As editors of a magazine devoted to the interests of engineers in this field, we are aware of the problems relating to materials, finishes, and component selection. We have long felt that a show devoted entirely to the interests of the designer would give him the opportunity to meet and discuss his problems with the many manufacturers of such products.

In the past, it has been necessary for the design engineer to attend shows in related fields to see the new designs and developments of interest. Now, with the First Design Engineering Show, he is getting a show, where at one time it will be possible to examine and evaluate the materials, finishes, mechanical components, power and control devices, and production processes that may be used in his new design. At Convention Hall in Philadelphia, more than 170 manufacturers will be exhibiting their products, and engineers from these companies will be on hand to discuss in detail the specifications and characteristics of these products.

The First Design Engineering Show is something new and different, and is expected to be repeated each year. Its success can be reflected only in the interest and support given by the designers and manufacturers.

Of added interest at the Show are a series of Conferences sponsored by the Machine Design Division of the American Society of Mechanical Engineers. The program for these sessions has been prepared by the chief editors of the leading publications in the design engineering field. Top speakers, well known in their fields, will talk on subjects such as: cost reduction in product design; recruiting and training men for the design engineering field; the problems of materials selection; methods of miniaturization; and the rights and compensation for inventions developed by company employees.

The First Design Engineering Show has the backing of the leading manufacturers, and the four leading design engineering publications. We, the editors of Product Engineering, recommend that all design engineers throughout industry make plans to attend the Design Engineering Show in Philadelphia, May 14 to 17.

FACTS TO HELP PLAN YOUR VISIT TO THE FIRST DESIGN ENGINEERING SHOW AND CONCURRENT ASME DESIGN ENGINEERING CONFERENCE, CONVENTION HALL, PHILADELPHIA, MAY 14-17, 1956

WHO SHOULD ATTEND?

Engineers who are responsible for research and the design, testing, and development of the new products, components and machinery used in all the key industries are invited to attend the Design Engineering Show and the ASME Machine Design Conference.

Engineers who function under the following titles are just a few of the large number who will find this show of particular interest: Research and Development Engineer, Product Design Engineer, Development Engineer, Designer, Design Analytical Engineer, Component Engineer, Test Engineer, Chemical Engineer, Methods Engineer, Metallurgist, Mechanical Design Engineer, Machine Design Engineer, Hydraulic and Pneumatic Engineer, Experimental and Research Engineer, Electrical Engineer, Consulting Engineer, Aeronautical Engineer, Director of Design, Cost Reduction Engineer, Machine Development Engineer, Mechanical Engineer, Project Engineer, Research Project Engineer, Stress Analyst, Structural Engineer, Test Design Engineer.

The meeting of such a group of key men in the design field will not only permit a free discussion of many common problems, but will give the designer a greater perspective of the entire design function.

WHAT WILL BE EXHIBITED?

The products of more than 170 manufacturers in the following categories will be shown in Convention Hall, Philadelphia, May 14-17, 1956. These products will be available for examination, comparison, and testing. Some of these are:

ELECTRICAL COMPONENTS

such as actuators, connectors, dynamotors, generators, insulators, meters, motors, switches and relays, rectifiers, solenoids, thermostats, wire and components, thermocouples, strain gages, timing motors, etc.

MECHANICAL COMPONENTS

such as axles, bearings, clutches, conveyors, drives, governors, mountings, couplings, speed reducers, timers, wheels, vibration mountings, springs, gears, belts and chains, lubricating equipment, etc.

ENGINEERING MATERIALS
metallic and non-metallic

such as aluminum alloys, clad metals, beryllium alloys, gray iron, high alloy steels, metal powders, titanium, magnesium, bearing alloys, nickel alloys, etc.; carbon, ceramics, cork, glass, jewels, paper, plastics, silicones, rubber, wood, graphite, etc.

FASTENERS

such as clips, nuts, retaining rings, rivets, welding, adhesives, etc.

FINISHES AND COATINGS

such as anodized finishes, chemical colorings, lacquers, paints and varnishes, plated coatings, etc.

HYDRAULIC AND PNEUMATIC COMPONENTS

such as accumulators, boosters, controls, pumps, cylinders, hose and tubing, piping, valves, etc.

SHAPES AND FORMS

such as die castings, drop forgings, formed non-metallics; perforated materials, press forgings, sand castings, tubing, etc.

ACCESSORIES

such as computers; drafting instruments, machines, supplies; recorders; reproduction equipment; supersonic generators; transducers, etc.

FACTS TO HELP PLAN YOUR VISIT TO THE FIRST DESIGN ENGINEERING SHOW AND CONCURRENT ASME DESIGN ENGINEERING CONFERENCE, CONVENTION HALL, PHILADELPHIA, MAY 14-17, 1956

Concurrent Design Engineering Conference, Convention Hall, Philadelphia, May 14-17, 1956, sponsored by the Machine Design Division of the ASME invites engineers to study industry's problems.

The chief editors of the leading publications in the product design field, serving as the Papers Committee, have drafted the program for the 4-day meeting. The session on Cost Reduction in Product Design will be devoted to General Electric Company's Value Analysis program. Finding and Training Engineers will be a panel session consisting of three members, who will stress the need for attracting men to the design field. Another subject will show how various mechanical and economic considerations dictate materials choices. Problems of Miniaturization will cover military as well as civilian products. The Recognition and Reward for Invention session will be a discussion of the Westinghouse Patent Award System.

HOW TO REGISTER FOR THE DESIGN ENGINEERING SHOW

Place:	Convention Hall, Philadelphia
Dates:	May 14-17, 1956
Hours:	12:30 pm to 5:30 pm daily, Monday through Thursday
Registration:	Registration for the show is FREE. Rapid Registration Tickets (to be filled out in advance to save time) can be obtained by writing to the Show Management:

Clapp & Poliak, Inc.
341 Madison Avenue
New York 17, New York

Request as many tickets for yourself and colleagues as you wish.

HOW TO REGISTER FOR THE DESIGN ENGINEERING CONFERENCE

Place:	Convention Hall, Philadelphia
Dates:	May 14-17, 1956
Hours:	9:30 am to 12:30 pm daily, Monday through Thursday
Registration:	Registration fee: $5 for ASME members, $10 for non-members, including a copy of Conference Proceedings. Register on arrival.

HOTELS

Write directly to the hotel of your choice in Philadelphia. Please be sure to specify the name of the person who will occupy room, date of arrival and probable departure. Mention the Design Engineering Show.

...a message from the editors of **Product Engineering**

THE FOLLOWING MANUFACTURERS WILL EXHIBIT THEIR ENGINEERED PRODUCTS AT THE First Design Engineering Show, Convention Hall, Philadelphia, May 14-17, 1956. QUALIFIED ENGINEERS WILL BE ON HAND TO SUPPLY INFORMATION ON THE LATEST DEVELOPMENTS. WE RECOMMEND YOUR ATTENDANCE.

Acme Steel Company
Air Maze Corporation
Alemite Division, Stewart-Warner Corporation
The Louis Allis Co.
Alloy Metal Wire Division
Aluminum Company of America
American Nickeloid Company
American Society of Mechanical Engineers
Amos Molded Plastics
Armstrong Cork Company
The Auburn Manufacturing Company

Bakelite Company, A Division of Union Carbide and Carbon Corporation
Balsa Ecuador Lumber Corporation
Bart Laboratories Division, Bart Manufacturing Corporation
Beemer Engineering Company
The Bellows Company
Boston Gear Works
Burndy Engineering Company, Inc.

Camloc Fastener Corporation
Cast Optics Corporation
Central Foundry Division, General Motors Corporation
Cerro de Pasco Corporation
Chicago Allis Mfg. Co.
Cleveland Cap Screw Co.
Coating Products
Colonial Alloys Company
Conolite Division, Continental Can Company, Inc.
Controlex Corporation of America
Coors Porcelain Company
Corning Glass Works
Cullman Wheel Co.
The Cuno Engineering Corporation
Curtiss-Wright Corporation, Metals Processing Division

The Franklin Daies Company
Detroit Controls Corp.
Diehl Manufacturing Company
The Dixon Corp.
The Dobeckmun Company
Doehler-Jarvis Division, National Lead Company
E. I. du Pont de Nemours & Co., Inc.
Durakool Inc.—Herma Seal Co. Inc.
Durametallic Corporation
Dynamic Gear Co., Inc.

Eaton Manufacturing Company, Reliance Division
Elastic Stop Nut Corporation of America
Electrical Manufacturing
Electro-Devices Inc.
Electroflex Heat Inc.
Ellis Associates
Encyclopaedia Britannica
Engineered Nylon Products, Inc.
Eriez Manufacturing Company

Falstrom Company
Ferguson Machine & Tool Co.
Flexible Tubing Corporation
Foote Bros. Gear & Machine Corporation
Formsprag Company
Frenchtown Porcelain Company
Fromson Orban Co., Inc.

The Garlock Packing Company
General Electric Company
General Findings & Supply Co.
The General Fireproofing Co.
The Glastic Corporation
The Globe Company, Grip-Strut Division
Gries Industries, Inc.
Gries Reproducer Corp.
Groov-Pin Corporation

Heim Company
Heli-Coil Corporation
Hermes Plastics Inc.
E. F. Houghton & Co.
Howard Industries, Inc.
Hunter Spring Company

The Improved Seamless Wire Company
Industrial Design Magazine
Industrial Equipment News
Instrument Specialties Company, Inc.
International Balsa Corporation
International Packings Corp.

Kennametal Inc.
Kimberly-Clark Corporation

L & L Manufacturing Company
L. O. F. Glass Fibers Company
The Lamson & Sessions Co.
The Lancaster Lens Company
La Salle Steel Co.
Leach & Garner
Lehigh Chemical Company
Lignum-Vitae Products Corporation
Linde Air Products Co., A Division of Union Carbide and Carbon Corporation
Linemaster Switch Corporation
Lovejoy Flexible Coupling Co.

Machinery Magazine
MacLean-Fogg Lock Nut Co.
Magnaflux Corporation
Mallory Sharon Titanium Corp.
Manheim Manufacturing & Belting Company
Marquette Metal Products Division, Curtiss-Wright Corporation
Materials & Methods
Mechanical Industries Production Company
Merkle-Korff Gear Co.
Micro-Balancing Inc.
Micro Switch Division of Minneapolis-Honeywell Regulator Co.
Minnesota Mining & Mfg. Co. Adhesives & Coatings Division
Multiple Extrusions Inc.
Mycalex Corporation of America

National Vulcanized Fibre Co.
Nelson Stud Welding, Division of Gregory Industries Inc.
Newark Wire cloth Company
New Hermes Engraving Machine Corporation
North Shore Nameplate Inc.

O'Sullivan Rubber Corporation

The Penton Publishing Company
Pic Design Corp.
The Polymer Corporation of Penna.
Post Machinery Company, Electronic Products Division
Potter & Brumfield
Product Engineering
Products Research Company

Reliance Electric and Engineering Company
Reynolds Metals Company
M. H. Rhodes, Incorporated
Rigidized Metals Corporation
Roehlen Engraving Works, Inc.
Roller Bearing Company of America
George D. Roper Corporation

Scovill Manufacturing Company
Simmons Fastener Corporation
Snow-Nabstedt Gear Corporation
Sparkler Manufacturing Company
Stahlin Brothers Fibre Works, Inc.
Standard Pressed Steel Co.
Stearns Magnetic Inc.
Stokes Molded Products Division, The Electric Storage Battery Co.
Stow Manufacturing Co.
Stratos Division, Fairchild Engine & Airplane Corporation
Stromberg-Carlson Company A Division of General Dynamics Corporation
Sweet's Catalog Service
Sylvania Electric Products Inc.

Teleflex, Incorporated
Thomas Publishing Company
Thomas' Register of American Manufacturers
Thomson Industries, Inc.
Thriftmaster Products Corporation
Tinnerman Products, Inc.
Titeflex, Inc.
Toyad Corporation
Tuttle & Kift, Inc.

U. S. Automatic Corporation
U. S. Royalite Division of United States Rubber Co.
U. S. Stoneware Company

Veeder-Root Incorporated

Wagner Electric Corporation
Warner Electric Brake & Clutch Co.
The Weatherhead Company
Weckesser Co.
Whitney Chain Company
Wolverine Tube Division, Calumet & Hecla Inc.

The Yale & Towne Manufacturing Company, Powdered Metal Products Div.

as of Feb. 28, 1956

THE DESIGN ENGINEERING SHOW

CONVENTION HALL, PHILADELPHIA

MAY 14-17, 1956

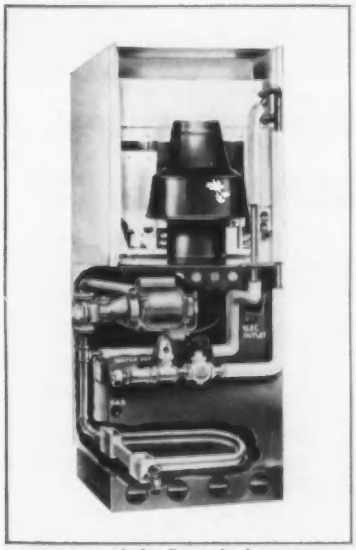
How to Control a Home Air Conditioner

No. 2 of a series — *Showing the broad application range of Fenwal Controls*

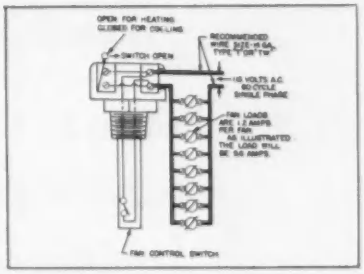
In this packaged high efficiency home heating and cooling system, a gas boiler and a water chiller combine to raise or lower the temperature of water circulating to the room conditioner units. The problem was to regulate the temperature of the water precisely, by supplying or removing just enough heat, so that the desired room temperature would be assured.

The solution was a Fenwal Snap-Action THERMOSWITCH control, Series 20000. Temperature range of this particular model is 25° to 225°, and the setting is at 100° ± 3°F. The device functions as a low limit common fan control for all unit room conditioners. In the heating operation it permits fans to operate when the boiler water temperature reaches 100°F, shuts them off when water temperature drops below 100°F. In the cooling operation the cover-mounted toggle switch permits continuous fan operation and acts as an off-on switch for all room unit fans.

A FENWAL SNAP-ACTION THERMOSWITCH® UNIT in this home air conditioner effectively controls both heating and cooling operations. This type of Fenwal device is ideal where a local bulb unit is required for accurate control with relatively large electrical loads.

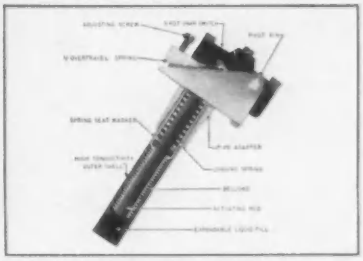


LOCATION of the Snap-Action THERMOSWITCH control in the air conditioner is at the boiler outlet, between the outlet and the pressure relief valve at the system supply outlet. This cut-away view shows its position relative to other elements in the system's central unit.


OPEN FOR HEATING
CLOSED FOR COOLING
SWITCH OPEN
RECOMMENDED WIRE SIZE #14 GA. TYPE T OR TW
115 VOLTS A.C. 60 CYCLE SINGLE PHASE
FAN LOADS ARE 1.2 AMPS. PER FAN. AS ILLUSTRATED THE LOAD STILL BE 5.6 AMPS.
FAN CONTROL SWITCH

FANS ARE CONTROLLED by the Snap-Action THERMOSWITCH unit as shown in this wiring diagram. Note the toggle switch (top), manually operated for heating or cooling, the thermostatically operated fan control switch (bottom), and the individual fan connections (right).

OPERATING PRINCIPLE. In the Fenwal Snap-Action THERMOSWITCH control, Series 20000 and 21000, contacts in the head are actuated by a push-rod connected to a bellows in the liquid-filled shell. High thermal activity, necessary to combine close control with "snap" contact actuation, is achieved by converting the cubical expansion of the liquid to linear motion of the push-rod at the snap switch. Since the liquid completely surrounds the bellows and is in direct contact with the external shell, fast response is assured. Units are available in six standard temperature ranges between −75°F and +300°F. Units are UL approved.



Many Other Uses

Among the growing list of applications for Fenwal Snap-Action THERMOSWITCH controls are: hot drink vending machines, commercial laundry equipment, commercial dishwashers and swimming pool heaters. Wherever accurate, sensitive temperature control under high electrical loads is required, the Series 20000 and 21000 units offer advantages found in no other thermostatic controls.

For Your Own Applications

Investigate the many different types of Fenwal temperature control and detection devices. Besides the 20000 Series described here, these include standard THERMOSWITCH units, Midgets, Miniatures, Indicating Controllers, etc. Send the coupon for new Catalog No. 500 and remember that Fenwal's engineering staff is always ready to help you solve any temperature control problem.

FENWAL INCORPORATED
24 Pleasant Street
Ashland, Mass.

Please send me your Catalog No. 500. Our specific problem is:.....

.....

.....

Name.....*Title*.....

Address.....

City.....*Zone*...*State*.....

Fenwal CONTROLS TEMPERATURES . . . *PRECISELY*

Carpenter... pioneering in improved Tool, Alloy and Stainless Steels through continuing research

TEMPERATURE: 110° F.
Permanent magnet assembly for watthour meter employing a magnetic shunt of Carpenter Temperature Compensator "30."
TEMPERATURE: -15° F.

When Precision Equipment Must Behave at Varying Temperatures...

Take Advantage of *Carpenter* High Nickel Alloys!

A specially-engineered steel in Carpenter's complete line of high nickel alloys is guarding the accuracy of watthour meter performance in all kinds of weather. Its use covers a wide range of electrical equipment such as watthour meters, voltage regulators, speedometers and aircraft tachometers.

This alloy, Carpenter Temperature Compensator "30", is produced by specialists under strict quality controls. It is another example of how Carpenter's pioneering role in producing *specialty* steels to meet *special* applications works for you in your effort to build better products at a reasonable cost.

And Temperature Compensator "30" is but one of many Carpenter specialties. Other "extremely sensitive" alloys in this line respond to very weak electrical currents . . . permitting you to design smaller, lighter weight units. Still another Carpenter High Nickel Alloy assures precision product performance with practically no size change through temperature ranges up to 400°F.

Take this step for product improvement, now: Write on your company letterhead for detailed information on Carpenter Temperature Compensator, Low Expansion, High Permeability and Glass Sealing Alloys in such forms as strip, wire, bars, tubing and forging billets. *The Carpenter Steel Co., 117 W. Bern St., Reading, Pa.*

Carpenter STEEL

high nickel alloys

Export Department: The Carpenter Steel Company, Port Washington, N. Y.—"CARSTEELCO"

The Best

Standardized gearing in stock . . .

are the easiest

housing sub-assemblies in stock . . .

to get

and standardized pinions in stock . . .

mean faster deliveries from stock!

FOOTE BROS.
LINE-O-POWER SPEED REDUCERS

Standardized interchangeable gearing – by Foote Bros. – lets you specify and get the particular reducer you want, in the quantities you need, direct from stock! Duti-Rated Lifetime Gearing in a complete range of interchangeable sizes, ratios and capacities are stocked and ready for assembly. Capacities range up to 200 H. P., ratios to over 2700 to 1. Standard foot and flange type cast housings are stocked, too, for straight or right angle drives. The drives you want are assembled from stock components and shipped as soon as your order is received. For a complete index to the almost endless variety of Line-O-Power reducers immediately available, write for your copy of the Line-O-Power catalog today. See for yourself how you can get more for your drive dollar . . . faster!

This trademark stands for the finest industrial gearing made!

T. M. REG. U. S. PAT. OFF.

FOOTE BROS.

Better Power Transmission Through Better Gears

FOOTE BROS. GEAR AND MACHINE CORPORATION
4545 South Western Boulevard, Department W, Chicago 9, Illinois

CALL ON R/M ENGINEERING SERVICE

TWO EXAMPLES OF THE THOROUGHNESS OF R/M PACKING ENGINEERING

Top-flight design engineering combined with superior molding techniques makes R/M Vee-Flex Rings and R/M Fabric Piston Cups ideal for hydraulic and pneumatic applications. And they're typical of the quality you can expect from R/M.

R/M VEE-FLEX is America's most copied packing. It's designed for every piston and rod and has proper interference for automatic sealing—even at pressures in excess of 6000 psi. Its other outstanding features are polymer saturated fabric; precision trimming; and rock-hard adapters to prevent extrusion, resist high pressures.

R/M FABRIC PISTON CUPS meet all your requirements. Accurate, carefully controlled molding assures dimensional uniformity and therefore maximum sealing effectiveness. Deeper, more thorough penetration of the compound into the fabric keeps wicking action from destroying the cup internally and resists ply delamination. These cups are thoroughly inspected, their hardness is consistent, and they adhere strictly to industry standard sizes.

The complete R/M line includes packings and gasket sheets for use against air, gas, water, steam, oil, chemicals, solvents, and food products. R/M also makes a complete line of asbestos textiles. If you have problems involving any of these materials or products, feel free to call on R/M's specialized engineering service.

For booklet shown, or other data, write, phone or wire:

PACKING DIVISION
Raybestos-Manhattan, Inc.
Passaic, N.J. • GRegory 3-2000

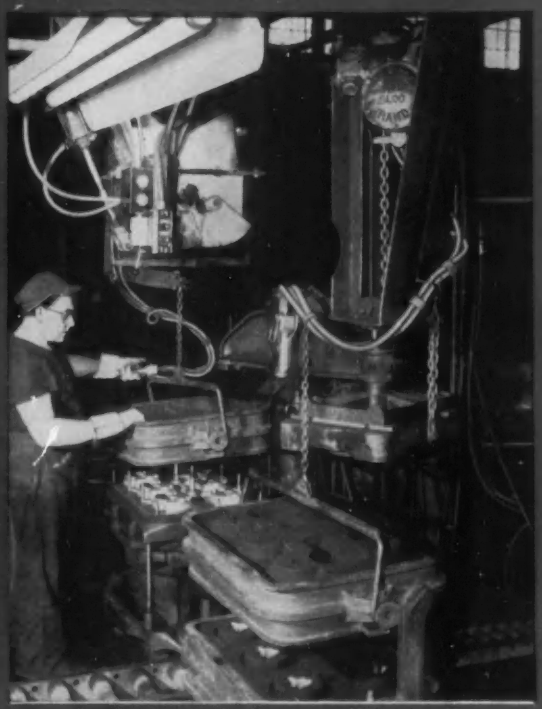
ASBESTOS TEXTILE DIVISION
Raybestos-Manhattan, Inc.
Manheim, Pa. • Manheim 5-2211

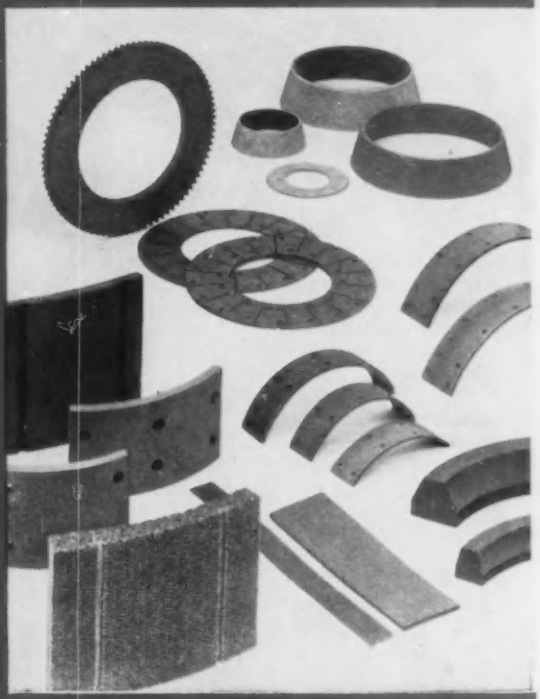
R/M

SPECIALISTS IN ASBESTOS, RUBBER, SINTERED METAL, ENGINEERED PLASTICS

Brake Blocks, Linings and Clutch Facings | Fan Belts and Radiator Hose | Mechanical Packings and Gaskets | Abrasive and Diamond Wheels | Industrial Drive Belts | Industrial and Automotive Hose

FOR HELP IN SOLVING YOUR PROBLEMS





ENGINEERED RUBBER HOSE

If your design calls for rubber hose, R/M has a superior construction to meet your specifications . . . or R/M will custom-engineer one that does—whether to resist acid, oil, heat, or of non-spark, non-contaminating construction. New Allflex Hose is ideal for handling air, water, oil, gases and mild chemicals . . . it's the *first* horizontal braided, mandrel-made hose for all-purpose use. Burst-proof Super-Master BW Steam and Air Hose with special flexible wire-braid reinforcement for rugged, high pressure service. Light Homoflex Hose with rope-like flexibility for air tools and water. Condor Flexible Rubber Pipe with Hydro-Lok flanges to replace metal pipe for wear and corrosion. General use or special purpose . . . you get design advantages of rugged strength plus maximum flexibility and light weight when you specify R/M hose. Whether it's hose, transmission or conveyor belts, V-belts, Poly-V® Drives or molded rubber products—you can depend on R/M.

For booklet shown, or other data, write, phone or wire:

MANHATTAN RUBBER DIVISION
Raybestos-Manhattan, Inc.
Passaic, N.J.
GRegory 3-2000

WOVEN OR MOLDED Friction Parts

As the developer of the first asbestos brake lining, Raybestos-Manhattan has always been first in friction. Where asbestos will best meet your friction requirements, R/M experience can determine precisely whether woven or molded asbestos parts, or a combination, will give you better performance. Where metal or any other materials are needed, remember that R/M offers the widest range of friction materials in the industry. Unlike other manufacturers, R/M works with *all* kinds of friction materials, so that you can be sure of completely *unbiased* advice whenever you consult an R/M engineer.

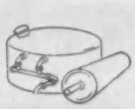
Write, phone or wire for your copy of R/M Bulletin No. 500. It's loaded with practical design and engineering data on all R/M friction materials.

EQUIPMENT SALES DIVISION
Raybestos-Manhattan, Inc.
6010 Northwest Highway
Chicago 31, Ill.
ROdney 3-2400

RAYBESTOS-MANHATTAN, INC.

FACTORIES: Passaic, N.J. • Bridgeport, Conn. • Manheim, Pa. • No. Charleston, S.C. • Crawfordsville, Ind. • Neenah, Wis. • Peterborough, Ontario, Canada

Conveyor Belts



Rubber Lined and Covered Equipment

Sintered Metal Friction Elements

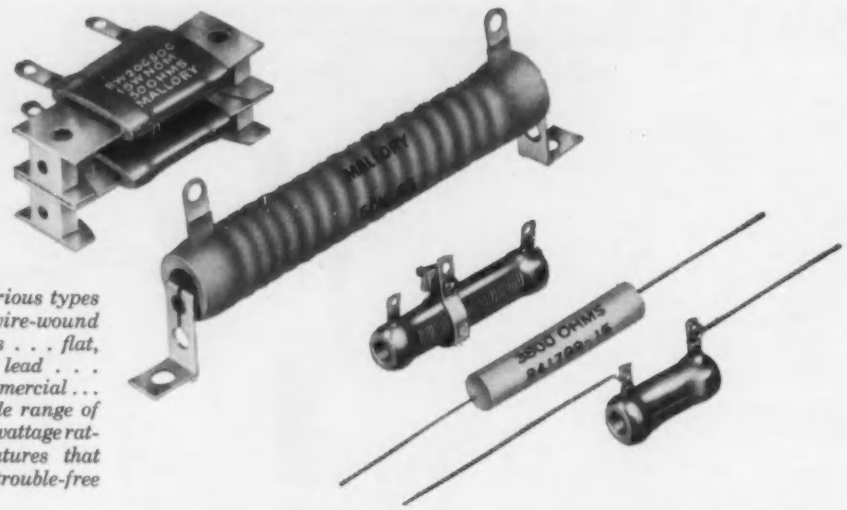
Asbestos Textiles

Teflon Tape, Packings, Sheets, Rods, Tubes

Engineered Molded Rubber and Plastics

R/M

MALLORY



Each of the various types of Mallory wire-wound power resistors . . . flat, tubular, axial lead . . . military or commercial . . . comes in a wide range of resistance and wattage ratings, with features that assure long, trouble-free service.

Mallory Power Resistors

with the Performance and Ratings You Need

Need wire-wound power resistors? Look to Mallory for performance to meet your specifications . . . types and ratings to match your circuits. A wide line gives you extensive selection.

RW Military Types to meet the requirements of MIL-R-26B, characteristics G and V, include classifications RW20 through RW24, RW29 through RW39 and RW49. Each is available in a broad range of resistances and wattages.

Commercial Vitreous Enamel Tubular Resistors cover wattage ratings from 3 to 200 watts.

Axial Lead Resistors, 4 and 7 watt sizes, are especially designed for economical use in television and other commercial electronic applications.

Adjustable Vitreous Enamel Resistors, in ratings up to 200 watts, feature a special construction to hold the element securely in place to prevent shorting between turns.

Cement Coated Resistors, designed for use where resistance to extreme humidity is not needed, offer good service at economical cost. 5 to 200 watts, in many resistance values.

Mallory resistors incorporate many design features to assure superior life, high physical strength and ability to stand thermal shock. The vitreous enamel coating is a special, non-alkaline material, sealing the wire element in a uniform coating that prevents entry of moisture and electrolytic corrosion.

A consultation with a Mallory resistor specialist can help you select the types best suited to your specific circuit requirements. For data, write to Mallory for Catalog 79-8.

Expect more . . . get more from

P. R. MALLORY & CO. Inc.

MALLORY

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Tuning Devices • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

Parts distributors in all major cities stock Mallory standard components for your convenience.

What size is a quality fastener?

Here are two ELASTIC STOP® nuts.
Each has the familiar red locking collar. Each is self-locking, vibration-proof and can be reused many times. Each is a fast, readily assembled one-piece unit . . . will maintain accurate adjustment anywhere on a bolt. Each will afford positive protection against thread corrosion . . . prevent liquid seepage along bolts. Each is manufactured in quantity. Each is exactly controlled as to quality of raw material, finished dimensions, class of thread fit, seat squareness and finish. Each has a record for precision and uniformly high performance that is unmatched.

But . . . one measures 1/10 inch across the flats; the other, 4 inches. Between these two, there are more than 530 different hex nuts in the ESNA line. They are the result of variations in height, material, finish and size.

Look to ESNA for the top quality self-locking fastener that fits your need best.

ELASTIC STOP NUT CORPORATION OF AMERICA

ESNA TRADE MARK

ROLLPIN TRADEMARK

Elastic Stop Nut Corporation of America
Dept. N58-42, 2330 Vauxhall Road, Union, N. J.
Please send the following free fastening information:

☐ ELASTIC STOP nut bulletin

☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name_____ Title_____

Firm_____

Street_____

City_____ Zone_____ State_____

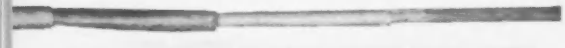
One or more of these G-E wires, cables, and cords can give your product extra advantages

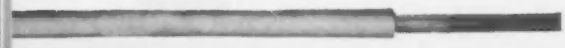
For many years, General Electric has helped solve the electrical equipment wiring problems of leading manufacturers. G-E wires, cables, and cords can also become an important part of your product. (A few examples of the many types of wires available are shown here). Where new products require it, G-E engineers will gladly assist product designers in meeting special wiring requirements. Write for free copy "G-E Wires, Cables, Cords for Product Designers." Address Section W163-467 Construction Materials Division. General Electric Company, Bridgeport 2, Connecticut.

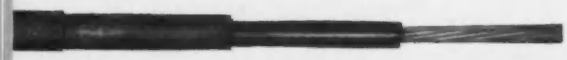
* Registered Trade-mark General Electric Company
** Trade-mark registration applied for by General Electric Company

Progress Is Our Most Important Product

GENERAL ELECTRIC







FLAMENOL* WIRES AND CORDS

MACHINE TOOL WIRE Small diameter, color coded, acid-, and oil-resistant. (90 C in air, 60 C in water, oil or coolant; 600 volts.)

APPLIANCE AND FIXTURE WIRE For general internal or external wiring of lighting and similar fixtures, and internal wiring of radios, refrigerators, washing machines, and the like.

APPLIANCE WIRE For wiring appliances where high temperature rating is required. 600 volts, not exceeding 105 C.

RIP CORD—SPT For table and floor lamps, radios, fans and other small devices. Smooth, attractive, long-wearing finish.

SILICONE RUBBER WIRES

APPLIANCE AND FIXTURE WIRE For sun lamps, therapeutic devices, and other high-wattage units. 600 volts, 200 C maximum copper temperature.

APPARATUS LEADS—CLASS H For high-temperature application where flexibility is required, such as motor and transformer leads. 600 volts, 200 C.

RUBBER CORDS

SO, SJO, S, SJ, SV Resistant to sunlight, oil, water, acids, alkalies and heat. Available for light-, medium-, or heavy-duty on household appliances, office machines, portable tools and for use in extreme conditions such as garages, packing houses, chemical plants, etc.

SP For light-duty applications in damp locations and for floor lamps, clocks, radios, etc.

PREENEX* HEATER CORD Outwears fabric type cords ten times. Water-, oil-, and grease-resistant. 300 volts, for 90 C service.

MOTOR LEADS Geoprene* cable for fractional hp motors, coils, ballasts, etc., particularly for use where wire must stand elevated temperatures.

MAGNET WIRE

ALKANEX WIRE** Insulated with heat-resistant polyester film that permits lighter, more compact motors . . . raises motor ratings as much as 25%. Temperatures up to 150 C, exceeding Class B.

FORMEX* WIRE Designed for motors, coils, and other windings where space is at a premium and resistance to moisture, fumes, and abrasion is required. Class A, temperatures up to 105 C.

DELTABESTON* WIRE For winding motors, lifting magnets, brake coils, generators, etc., subject to high ambient temperatures and intense operating heat. Class B, temperatures up to 130 C.

DELTABESTON WIRE

RANGE WIRE An improved appliance lead wire designed for increased dielectric strength and moisture resistance. 300 volts, 125 C.

APPLIANCE WIRE Available with smokeless or moisture-resistant insulation.

APPLIANCE LEAD WIRE Recommended for use on appliances such as sterilizers, etc., where both heat and moisture are a problem.

FIXTURE WIRE For all types of interior lighting fixtures and other high-wattage units such as sunlamps, etc.

SWITCHBOARD WIRE Will resist heat, flame, oil, and corrosive vapors.

You can set a new High Torque Unbrako self-locking socket set screw and forget it—it stays tight

There are several reasons: the deeper socket which gives you better purchase with the wrench; the rounded socket corners which eliminate the sharp corners where cracks start; the special methods of heat treatment in atmosphere-controlled furnaces; the development of fully formed threads.

Up to 40% higher tightening torque— a new Unbrako feature

RECOMMENDED SOCKET SET SCREW TIGHTENING TORQUES (Inch-Pounds)

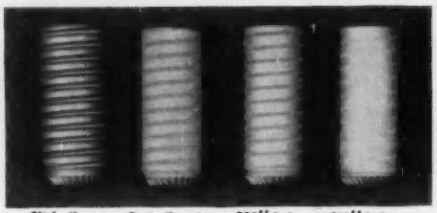
SCREW SIZE	UNBRAKO	SET SCREW B	SET SCREW C	MINIMUM DIFFERENTIAL %
#4	5	3.9	3.5	28
#5	9	7.8	7.4	15
#6	9	7.8	7.4	15
#8	20	14.7	14.5	36
#10	33	26.5	25	25
1/4	87	62	60	40
5/16	165	122	125	32
3/8	290	198	225	29
7/16	430	309	350	23
1/2	620	460	500	24
5/8	1225	1106	1060	11
3/4	2125	1540	1800	18
7/8	5000	3660	4600	9
1	7000	5025	6500	8

ALL UNBRAKOs can withstand higher tightening torques than ordinary set screws. For example, the recommended torque for a ¼" UNBRAKO is 87 inch-pounds—40% greater than that recommended for an ordinary set screw.

These microphotographs illustrate just what fully formed threads do for the new High-Torque UNBRAKO. They make the whole screw stronger. The metal is compressed into the closely knit grain structure that you see. The grain flow follows the contour of the threads. There are no straight lines along which shear can occur. The UNBRAKO retains its flow lines even when ground down to .010" below root diameter. Screws with cut or ground threads lose thread form at root diameter.

You can't buy a better set screw than an UNBRAKO. See your authorized industrial distributor today. Or write STANDARD PRESSED STEEL Co., Jenkintown 28, Pa.

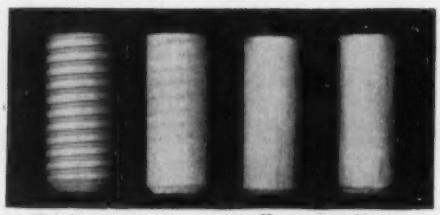
Unbrako Set Screw



Pitch diameter Root diameter .005" below root diameter .010" below root diameter

Fully formed threads make the whole screw stronger. The metal is compressed into a closely knit grain structure. The grain flow follows the contour of the threads. The UNBRAKO retains its flow lines even when ground down to .010" below root diameter. Screws with cut or ground threads lose thread form at root diameter.

Ordinary Set Screw



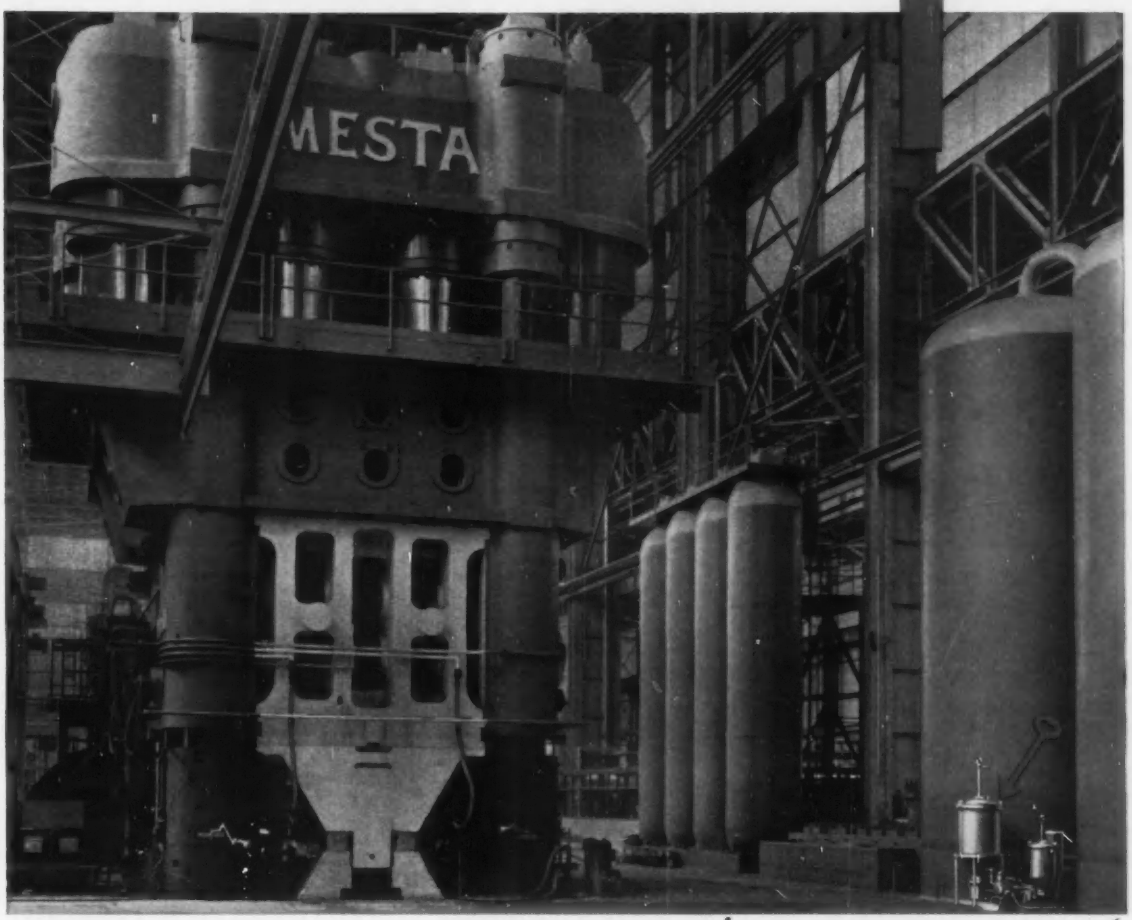
Pitch diameter Root diameter .005" below root diameter .010" below root diameter

STANDARD PRESSED STEEL CO.

UNBRAKO SOCKET SCREW DIVISION SPS JENKINTOWN PENNSYLVANIA

Farval automatic system lubricates world's largest forging press at Alcoa

FARVAL—
Studies in Centralized Lubrication No. 185



KEYS TO ADEQUATE LUBRICATION—
Wherever you see the sign of Farval—the familiar central pumping station, valve manifolds, dual lubricant lines—you know a machine is being properly lubricated.

The Farval central stations, visible at lower right, serve this 50,000-ton forging press.

●Pioneer in lubricating presses of all sizes, Farval was chosen to lubricate this 50,000-ton Mesta Press installed recently in the Cleveland works of the Aluminum Company of America.

With equipment of this size, the importance of a lubrication system increases many fold. It *must* be adequate. It *must* be dependable. It *must* function without shutdown. Farval fills the bill—delivering oil or grease unfailingly, in exact amounts required whenever needed. The press is protected, man hours and lubricant saved, guesswork lubrication eliminated, steady production maintained.

You will find Farval representatives ready to serve you in all major industrial centers. See how Farval pays for itself many times over—write for Bulletin 26-R. The Farval Corp., 3279 E. 80th St., Cleveland 4, O.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing.
In Canada: Peacock Brothers Limited.

There's **MORE** rating selection available in Allis-Chalmers **MOTORS**

To meet design needs...

Allis-Chalmers Offers Complete Line of Rib-Type MOTORS from 1 to 100 Hp

Allis-Chalmers, a pioneer in rib-type TEFC motor design, is the only leading manufacturer offering a complete line of these motors from 1 to 100 hp. The many cost-saving features of deep-rib construction can be applied in a variety of uses . . . both indoors and out.

Here's why these motors pay dividends:

MORE cooling surface — Rib-type design provides reserve cooling capacity in dirty locations.

MORE iron—Cast-iron frame and external parts assure rigidity and resistance to corrosion.

MORE copper — Allis-Chalmers greater use of copper increases electrical life.

MORE lubrication provisions — Large grease reservoirs surround bearings. Provision made for in-service relubrication — important where moisture or corrosive vapors contaminate grease.

As a new machinery component or as replacement, specify Allis-Chalmers. To find out more, contact your nearby Allis-Chalmers distributor, district office, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

A-4941

ALLIS-CHALMERS

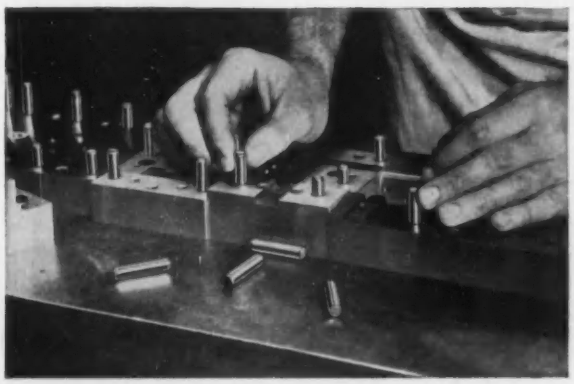
"STOCK ANSWER"
to many a design problem

ALLEN DOWEL PINS

ALLEN DOWEL PINS are being profitably employed in a thousand and one ingenious ways beyond their conventional applications in tool and die work — as economical roller bearings, as axles, precision plugs, hinges and wrist pins to name a few.

If you have an application that will utilize the great strength, accuracy and fine finish of Allen Dowel Pins, you can save substantially on the cost of your product — because you can secure them at favorable prices right from your Allen Distributor's stock.

Check the quick facts at the right and write directly to Allen's Engineering Department for further technical information.

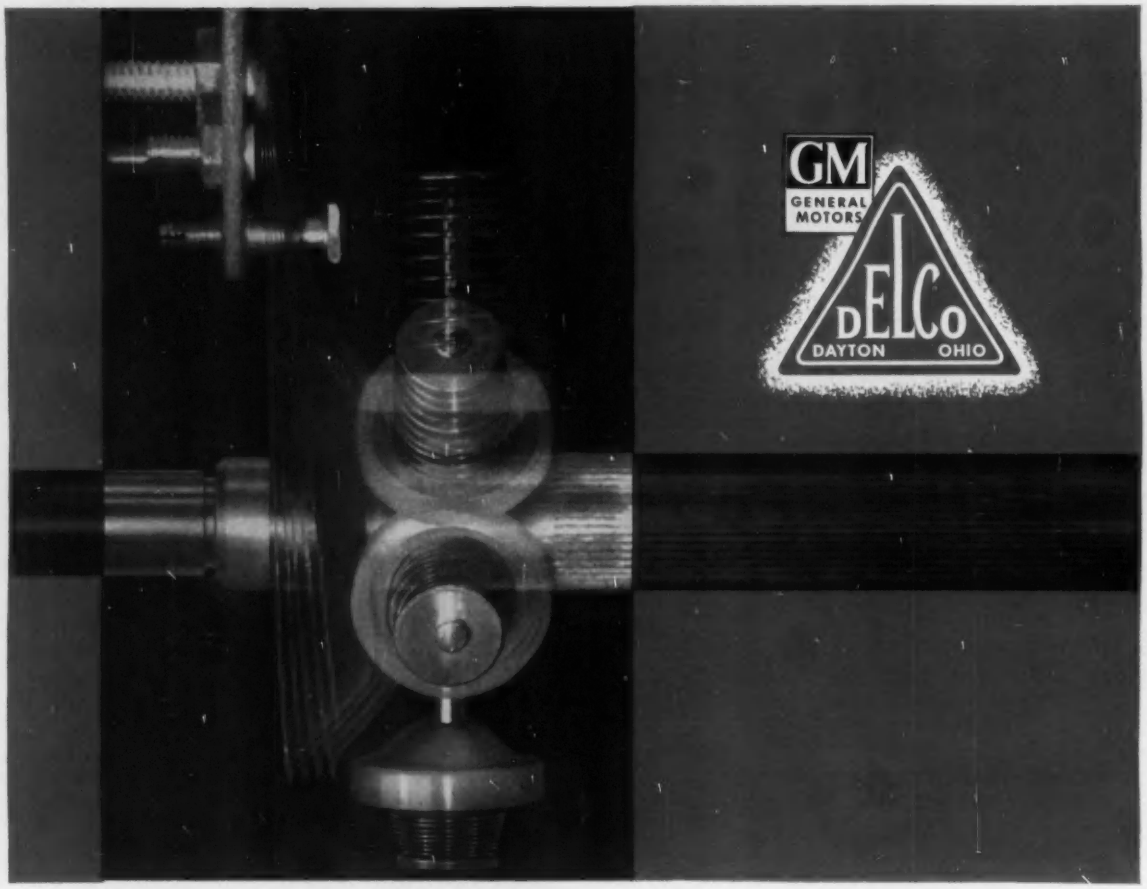


SPECIFICATIONS

- Made from Allenoy heat treated steel. Surface hardness 62-64, Rockwell C scale; core hardness 52-54. Case depth .010" to .020" depending on size.
- Single shear strength 160,000 to 180,000 p.s.i.
- Surfaces precision ground to ± .0001" with micro-inch finish of 6 RMS max.
- Sizes: Diameters, ⅛" to 1". Lengths, ⅜" to 6".
- Two standard oversizes — .0002 for press fits between mating parts, or .001 for repair work, or holes machined oversize.

ALLEN HEAD

ALLEN
MANUFACTURING COMPANY
Hartford 2, Connecticut, U.S.A.

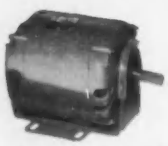


most UNCOMPLICATED starting switch going

ANOTHER EXCLUSIVE FOR DELCO *Electric* MOTORS

That's all! Just three simple parts *snap* open the starting switch on Delco Products FHP Electric Motors. This utter simplicity of action—compared to other switches with as many as 12 parts—means longer switch life, fewer service problems and greater customer satisfaction with your product. And the switch is practically noiseless when starting and stopping.

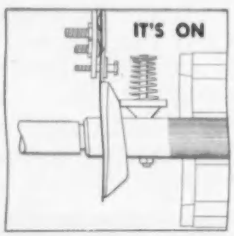
This exclusive Delco Products starting switch has other advantages, too. It acts consistently within a few rpm of the same speed every time—time after time after hundreds of thousands of times. The nylon weight is free to rotate when in contact with the ceramic-coated contact arm, practically eliminating wear. The spindle is self-cleaning so dirt, corrosion or rust cannot interfere with its operation—as they can with conventional designs.



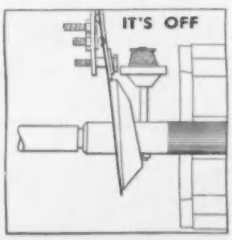
New Delco Products 48-frame motor

This is a sample of the kind of superior engineering that makes Delco Products electric motors the right motors to power your product.

Get the facts on the Delco Products electric motor for your particular needs. Contact your nearby Delco Products Sales Office or Delco Products, Dayton, Ohio.



It's quiet, positive . . . practically never wears out . . . operates consistently within a few rpm.



GM GENERAL MOTORS

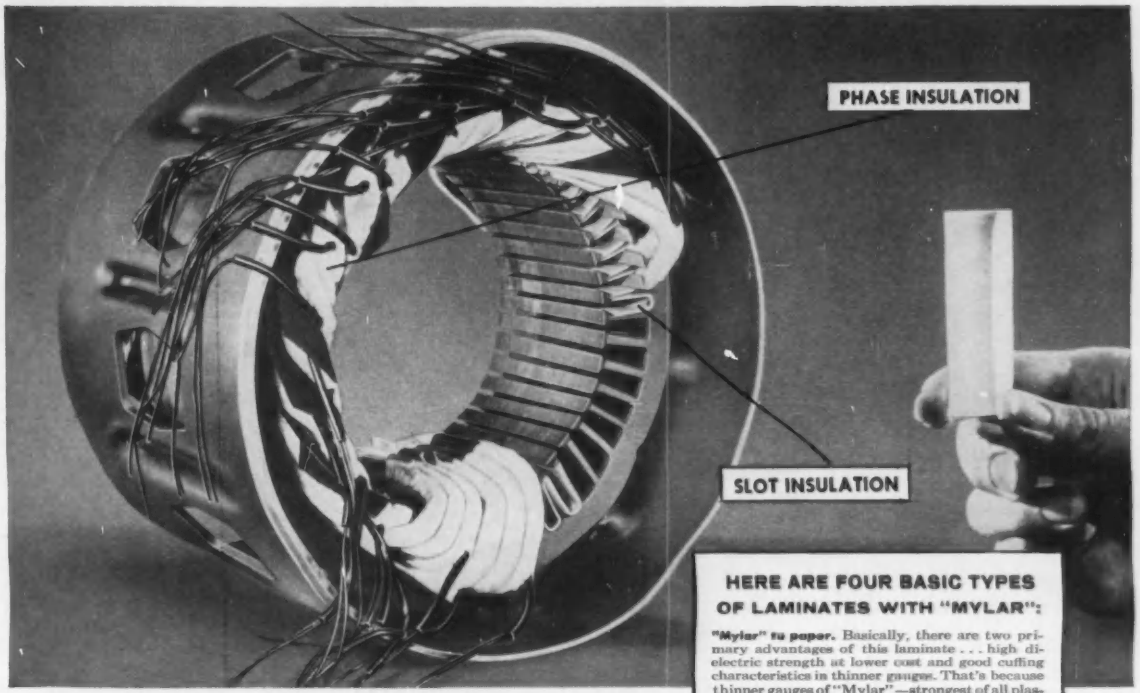
DELCO *Electric* MOTORS

DELCO PRODUCTS, DIVISION OF GENERAL MOTORS, DAYTON, OHIO

Proved best by Performance!

Now available—a complete line of improved insulating laminates with

Du Pont MYLAR®



Du Pont "Mylar"* polyester film is now available for a wide variety of electrical insulating uses, some of which are illustrated above. These laminates offer superior performance . . . make possible important space savings. That's because laminates with "Mylar" provide exceptionally high dielectric strength and heat stability . . . plus remarkable resistance to moisture and many chemicals.

While those types listed on the right are basic, there are numerous other combinations of "Mylar" available, depending on specific needs. So check your supplier today. It will pay you to investigate the new combinations of "Mylar" in his line. Or send in the coupon below for names of converters who manufacture electrical laminates with "Mylar". Be sure to mention the specific application you have in mind.

HERE ARE FOUR BASIC TYPES OF LAMINATES WITH "MYLAR":

"Mylar" to paper. Basically, there are two primary advantages of this laminate . . . high dielectric strength at lower cost and good cutting characteristics in thinner gauges. That's because thinner gauges of "Mylar"—strongest of all plastic films—can be used.

"Mylar" to glass cloth. Because "Mylar" remains dimensionally stable from −60° to 150° C., "Mylar" laminated to glass cloth offers superior insulation at both high and low temperatures. In addition to high flexibility, this laminate has good forming characteristics in thinner gauges.

"Mylar" to asbestos. Excellent for motors and generators operating in the Class "B" temperature range. Coated asbestos laminated to this tough polyester film produces a stronger product with increased moisture resistance.

"Mylar" to mica. This laminate offers maximum insulation plus flexibility. In short, mica is easier to work with when laminated to "Mylar". Costs are lower too because thinner gauges of mica can be used . . . Du Pont "Mylar" gives the mica "body."

*Du Pont manufactures the basic material "Mylar"—not finished electrical laminates. "Mylar" is Du Pont's registered trademark for its brand of polyester film.

DU PONT
REG. U.S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

DU PONT ® MYLAR POLYESTER FILM

E. I. du Pont de Nemours & Co. (Inc.), Film Dept., Room P-4
Nemours Bldg., Wilmington 98, Delaware.

Please send your new booklet (MB-5) featuring "Mylar" polyester film in motors plus names of converters who manufacture laminates with "Mylar".

Application_____

Name_____

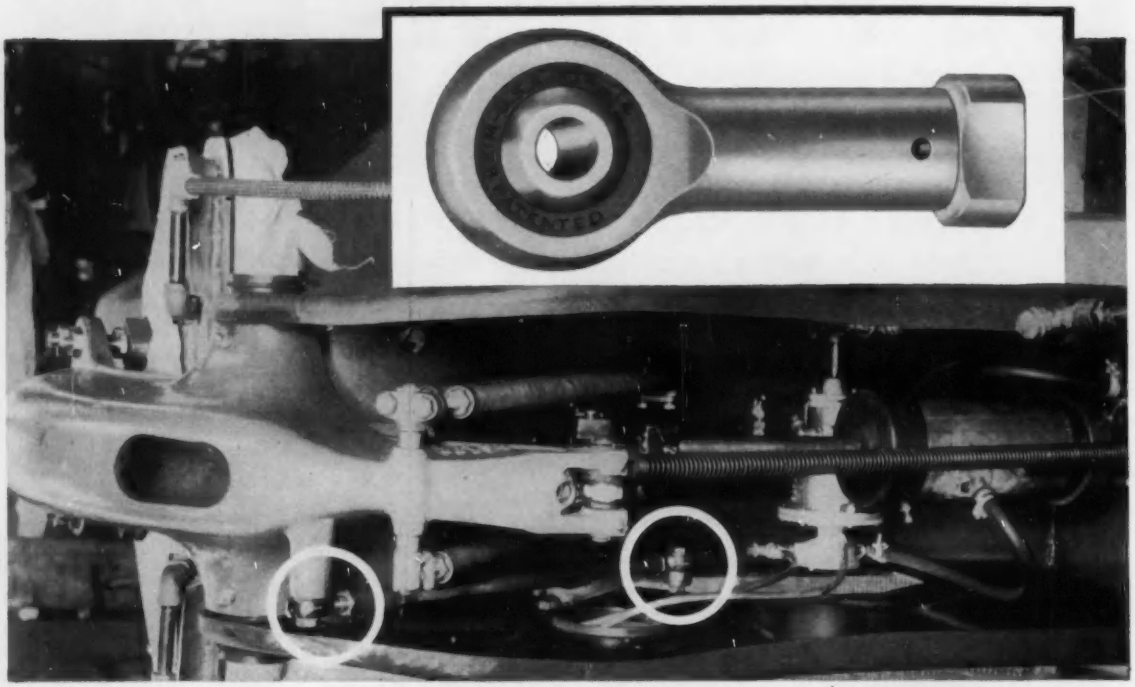
Firm_____

Address_____

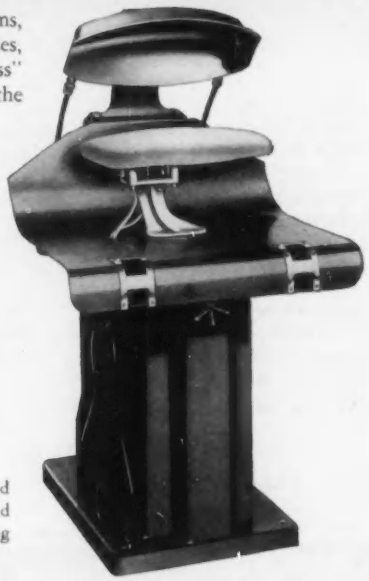
City_____ State_____

. . . For Ease of Mounting . . . choose . . .

HEIM Spherical Bearing Rod Ends



Designed for general use in pressing the more difficult small lays on uniforms, smocks, and house dresses, and for finishing small garments such as shorts, blouses, and children's dresses, the "Prosperity Utility Oval Shaper with Square Ends Press" uses Heim Rod Ends as the end members of the connecting link between the hydraulic check and other operating parts.



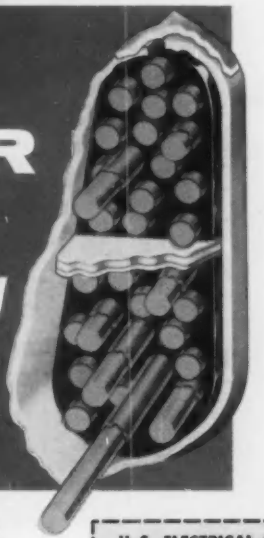
Heim Rod Ends were chosen for this important linkage not only for their ease of mounting, but because their self-aligning feature was required to compensate for the hydraulic check link and the operating levers swinging out of plane with each other.

To familiarize prospective users of Heim Spherical Bearings and Rod Ends with the unique, single ball construction, we would like to mail you a free sample. Or write for the complete catalog of Heim Bearings.

THE HEIM COMPANY FAIRFIELD, CONNECTICUT

Motor Burnouts are preventable!

U. S. MOTOR WINDINGS
Asbestos-Insulated to resist burnouts



Eliminate causes and avoid failure

Extensive surveys reveal the astonishing fact that a large percentage of motor burnouts occur from *avoidable* causes such as overload, clogged passages or confined spaces, improper circuit protection and bearing failure. These conditions, if not corrected, result in overheating of the windings. Ordinary insulations are organic and will carbonize when excessively heated, resulting in motor burnout.

As a means of increasing motor life and to resist burnouts the windings in U.S. motors are insulated with inorganic *asbestos*, greatest of heat-resisting elements and Nature's only incombustible fiber.

Asbestos is used in sheet form to separate the windings and in a compounded form, vibro-applied, as a filler to completely isolate each wire. Coil ends are further protected with a built up armor of several coatings of an asbestic compound that smooths the surface and forms an impervious protection against moisture.

In Bulletins portraying the outstanding features of U.S. Uniclosed, Varidrive, Syncrogear and Totally-Enclosed motors, the application of asbestos is interestingly presented, proving its life-lengthening characteristics. Get these Bulletins. Mail the Coupon.

U.S. Electrical MOTORS

Mail Coupon Today ▶

U. S. ELECTRICAL MOTORS Inc. PEN-4
P.O. Box 2058, Los Angeles 54, Calif., or Milford, Conn.
Send Booklet(s) showing advantages of asbestos-protection in

☐ Uniclosed Motors ☐ Varidrives
☐ Totally-Enclosed Motors ☐ Syncrogear Motors

NAME_____
COMPANY_____
ADDRESS_____
CITY_____ ZONE_____ STATE_____

In ore clean-up buckets...

HALF AS THICK! In the trays for giant ore clean-up buckets, 1¼" USS "T-1" Steel Plate, with a yield strength of 90,000 psi., replaces cast trays which were as much as 2½" thick. The new buckets—lighter in weight by more than half a ton—and expected to outperform the heavy cast trays, will be used at United States Steel's South Works.

UNITED STATES STEEL CORPORATION, PITTSBURGH • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. • UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS "T-1" CONSTRUCTIONAL ALLOY STEEL

USS

FABRICATION SIMPLIFIED WITH USS "T-1" STEEL

(plus weight reduction of more than ½ ton)

The trays of ore clean-up buckets must have phenomenal shock and abrasion resistance to hold up under constant scraping and scouring along the steel bottoms of ore boats. They are commonly made of heavy steel castings. But recently, Blaw-Knox Company, Pittsburgh, Pa., *fabricated* trays for several new buckets from USS "T-1" Steel Plate. This amazing new alloy steel assures the needed strength and durability, plus important fabricating advantages.

LESS WEIGHT—LESS EXPENSE

Biggest single advantage of fabricating from USS "T-1" Steel Plate is less weight. New trays weigh only 4,021 pounds each, compared to 5,068 pounds for comparable cast manganese steel trays. Thus, USS "T-1" Steel decreases the weight of the bucket and reduces shipping and handling costs.

What's more, fabrication from USS "T-1" Steel simplified the building of these huge buckets. It eliminated the expensive patterns needed for cast trays. Because USS "T-1" Steel has tremendous resistance to impact abuse and abrasion, it is expected that it will outperform previously used materials.

For these ore buckets, USS "T-1" Steel is flame-cut to size, *cold formed* in a 1,250-ton press, drilled and then riveted to the bucket shell. USS "T-1" also can be welded—without pre- or post-heating. Because of its unusual combination of properties, it is cutting costs in many rugged applications.

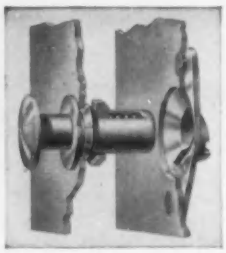
LOOK AROUND YOUR SHOP

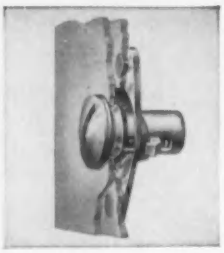
In your own equipment, or in the products you make for others—wherever you would like to increase service life . . . wherever you would like to reduce fabricating costs of heavy-duty parts—look into the possibility of using USS "T-1" Steel. Competent technical advice is always available, of course — free of charge — from United States Steel. Write, wire, or phone for complete information. United States Steel, Room 5287, Pittsburgh 30, Pa.

See "THE UNITED STATES STEEL HOUR"—Televised alternate weeks—Consult your newspaper for time and station.

UNITED STATES STEEL

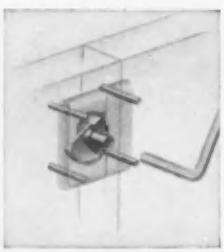
3 ways to save on assembly costs





QUICK-LOCK For fastening removable access doors and panels. Because of its ease of installation, QUICK-LOCK is ideal for assembling removable panels. A 90° turn locks it in place. Stud is self-ejecting when unlocked; visual inspection shows whether fastener is locked. Spring loading takes initial load; solid supports carry increased load. Available in a wide range of sizes.

SPRING-LOCK One-piece fastener for blind holes has load-carrying steel spring wire. Spring steel arms lock fastener securely, prevent loosening under vibration. SPRING-LOCK will work with varying panel thicknesses, locks with a twist of the wrist. Made in all-metal and plastic with steel insert. The molded design permits heads to be made in various shapes for refrigerator shelf supports, washer knobs, brackets. Available in a wide variety of shapes and sizes, and also in custom designs.



ROTO-LOCK Serrated, tapered cam is engaged by formed lug as fastener is locked. Cam action draws panels together tightly, insures locking even under conditions of misalignment. Opens easily for demounting. ROTO-LOCK carries heavy tension and shear loads; can be used for air and water-tight seals: recesses completely into panels. Solidly built without springs or delicate mechanical parts, unaffected by arctic temperatures or field service.

Simmons

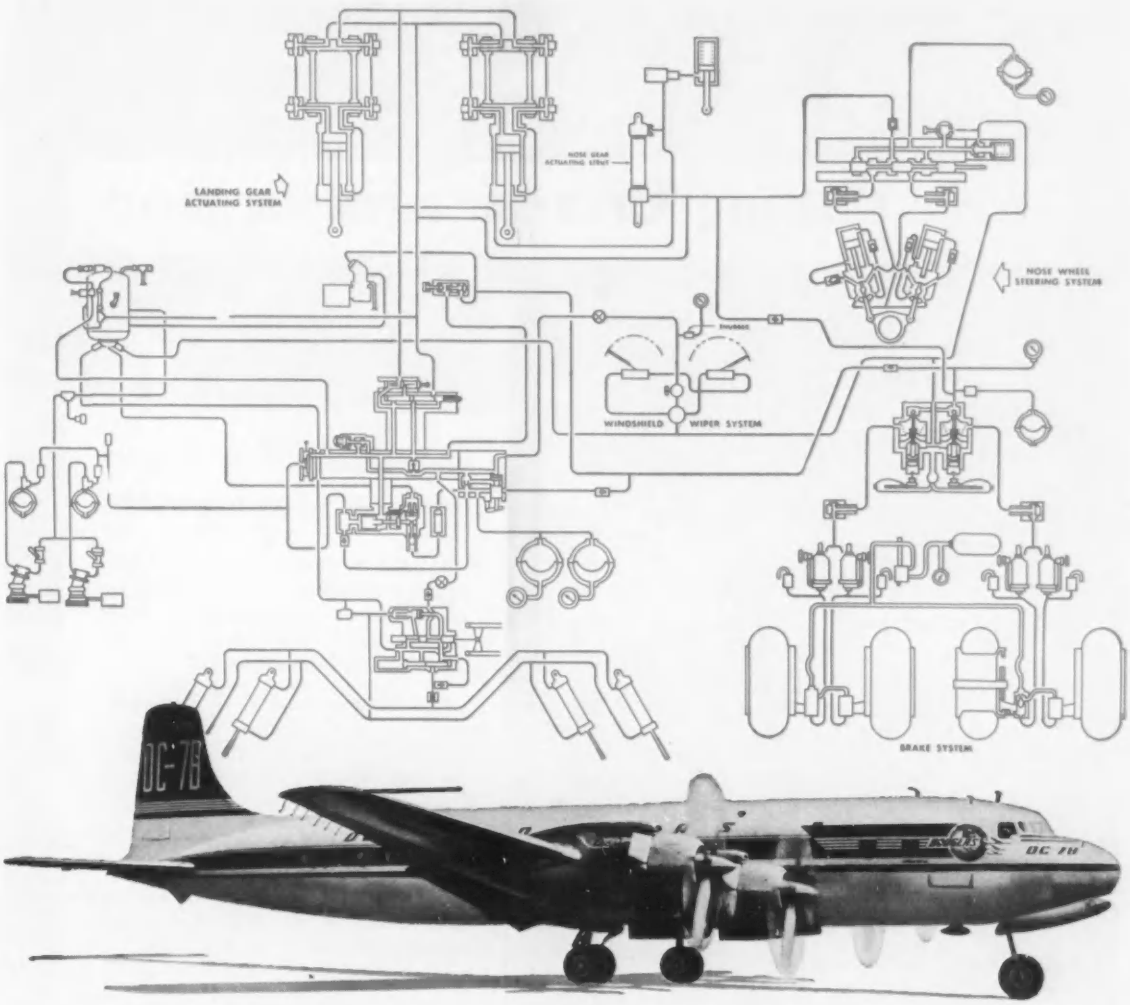
QUICK-LOCK
SPRING-LOCK
ROTO-LOCK
LINK-LOCK
DUAL-LOCK

JUST OUT!
NEW 36-PAGE CATALOG WITH APPLICATIONS
SEND FOR IT!

Simmons Fasteners are widely used in refrigerators, washing machines, electrical equipment, electronic assemblies, prefabricated portable shelters, coolers, demountable furniture. Every Simmons Fastener is a service-proved design with a long record of assembly-cost saving in many industries.

If you are interested in cutting your costs, turn to Simmons Fasteners—the fasteners with *uses unlimited*. Write for samples and catalogs today.

SIMMONS FASTENER CORPORATION
1751 NORTH BROADWAY, ALBANY 1, NEW YORK



Enjay Butyl rubber— vital artery in newest airliners

Douglas chooses Enjay Butyl for rubber components of the hydraulic systems in many of its famous DC-7 airliners. These components, which help assure the dependable operation of everything from wing flaps to landing gear, are proving over millions of air miles their durability and resistance to wear.

Versatile Enjay Butyl rubber may well have a place in *your* operation. It will pay you to investigate the many technical advantages it has over other types of rubber. Its price and ready availability are advantages, too. For full information, and for technical assistance in the uses of Enjay Butyl, contact the Enjay Company today.

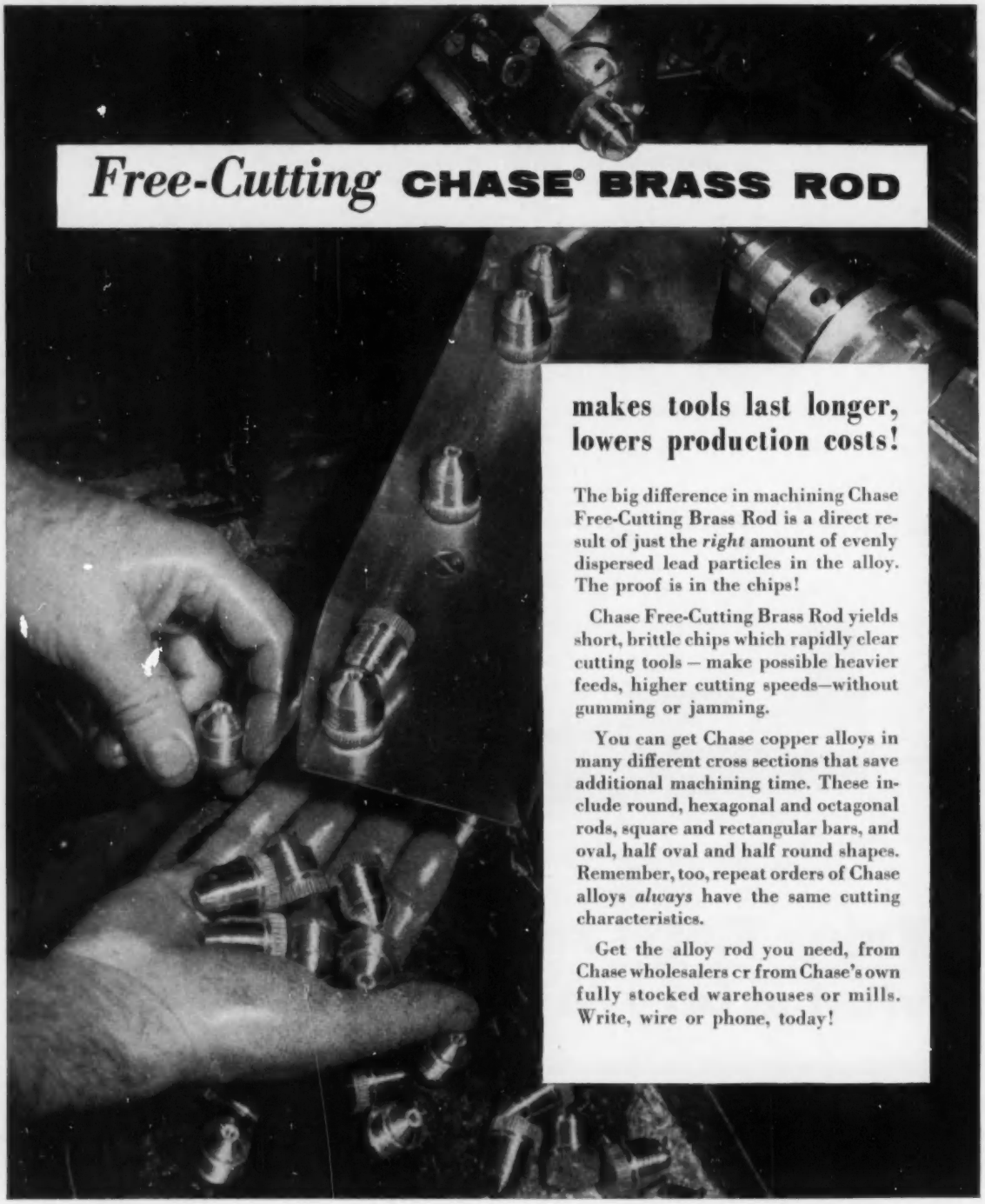
ENJAY BUTYL

ENJAY *Pioneer in Petrochemicals*

ENJAY COMPANY, INC., 15 West 51st Street, New York 19, N. Y.

Other offices: Akron • Boston • Chicago • Los Angeles • Tulsa

Enjay Butyl is the super-durable rubber with *outstanding* resistance to aging • abrasion • tear • chipping • cracking • ozone and corona • chemicals • gases • heat • cold • sunlight • moisture.



Free-Cutting CHASE® BRASS ROD

makes tools last longer, lowers production costs!

The big difference in machining Chase Free-Cutting Brass Rod is a direct result of just the *right* amount of evenly dispersed lead particles in the alloy. The proof is in the chips!

Chase Free-Cutting Brass Rod yields short, brittle chips which rapidly clear cutting tools — make possible heavier feeds, higher cutting speeds—without gumming or jamming.

You can get Chase copper alloys in many different cross sections that save additional machining time. These include round, hexagonal and octagonal rods, square and rectangular bars, and oval, half oval and half round shapes. Remember, too, repeat orders of Chase alloys *always* have the same cutting characteristics.

Get the alloy rod you need, from Chase wholesalers or from Chase's own fully stocked warehouses or mills. Write, wire or phone, today!

Chase

BRASS & COPPER CO.

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

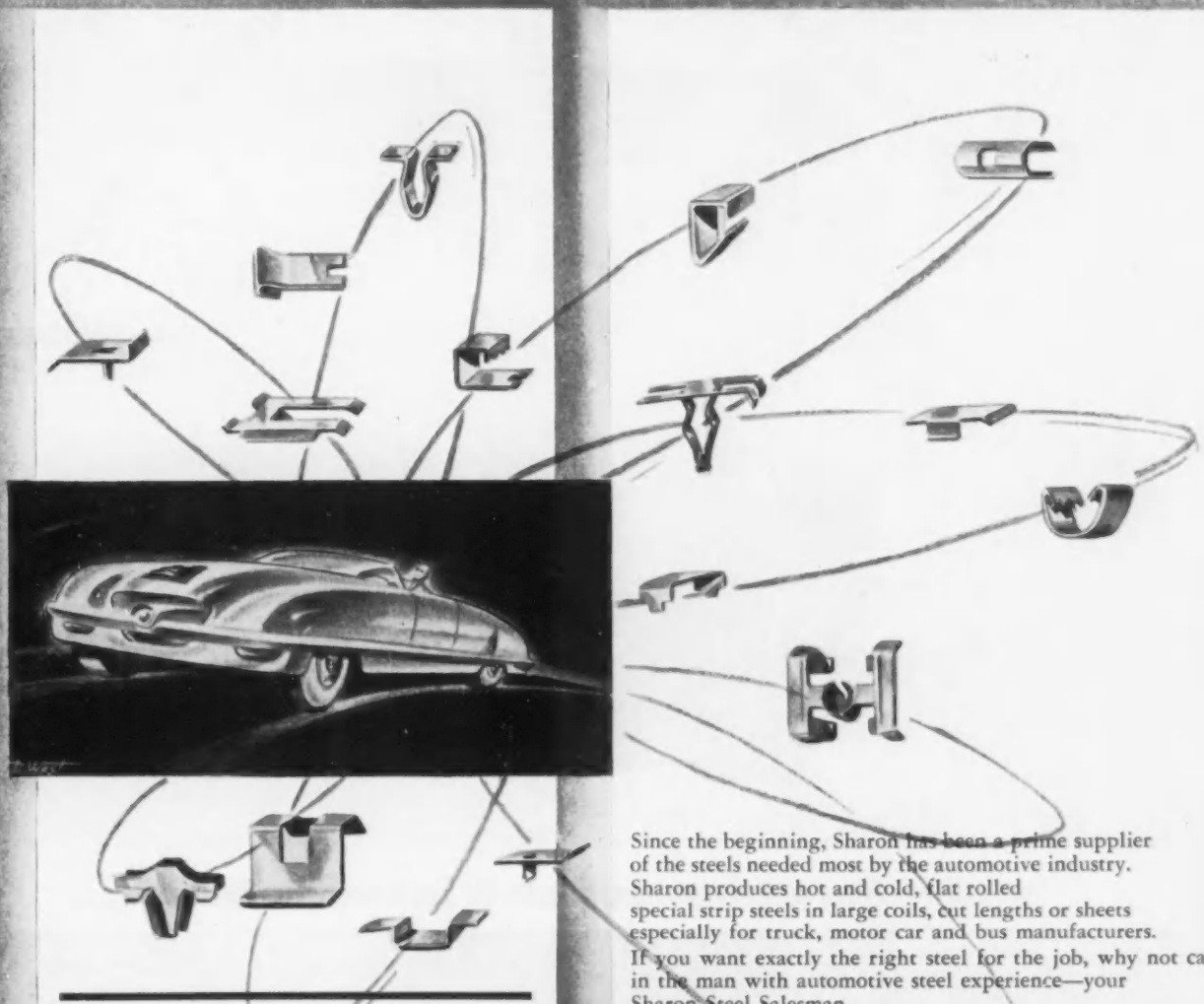
NEW CHASE ROD and WIRE MOVIE "IN THE CHIPS"

Contact your nearest Chase Warehouse or Sales Office now to arrange for a loan of this informative film for showing in your own organization. Write on your Company letterhead.

The Nation's Headquarters for Brass & Copper (†sales office only)

Atlanta	Chicago	Denver	Indianapolis	Minneapolis	Philadelphia
Baltimore	Cincinnati	Detroit	Kansas City, Mo.	Newark	Pittsburgh
Boston	Cleveland	Grand Rapids†	Los Angeles	New Orleans	Providence
Charlotte†	Dallas	Houston	Milwaukee	New York	Rochester†
St. Louis	San Francisco	Seattle	Waterbury		

If you're part of the AUTOMOTIVE Industry you should know about SHARON SPECIAL STEELS



Automotive Manufacturers

Should Have These Booklets:

430 STAINLESS — a complete review of a popular straight chromium grade.

GALVANITE* — The story of one of the most popular hot dip zinc coated steels.

SHARONART* — Rolled-in design steels with excellent illustrations.

SHARONSTEEL

*Trademark registered by Sharon Steel Corporation

Since the beginning, Sharon has been a prime supplier of the steels needed most by the automotive industry. Sharon produces hot and cold, flat rolled special strip steels in large coils, cut lengths or sheets especially for truck, motor car and bus manufacturers.

If you want exactly the right steel for the job, why not call in the man with automotive steel experience—your Sharon Steel Salesman.

Typical Sharon products used by leading automobile and automobile parts manufacturers include:

STAINLESS
both straight chrome and chrome-nickel

SPRING STEELS
of every analysis

SHARONART
the steel with the rolled-in design surface

COATED STEELS
Galvanite* Brite Zinc-Electro Galvanized - Terne

N.A.X. and COR-TEN
hi-tensile low-alloy steel

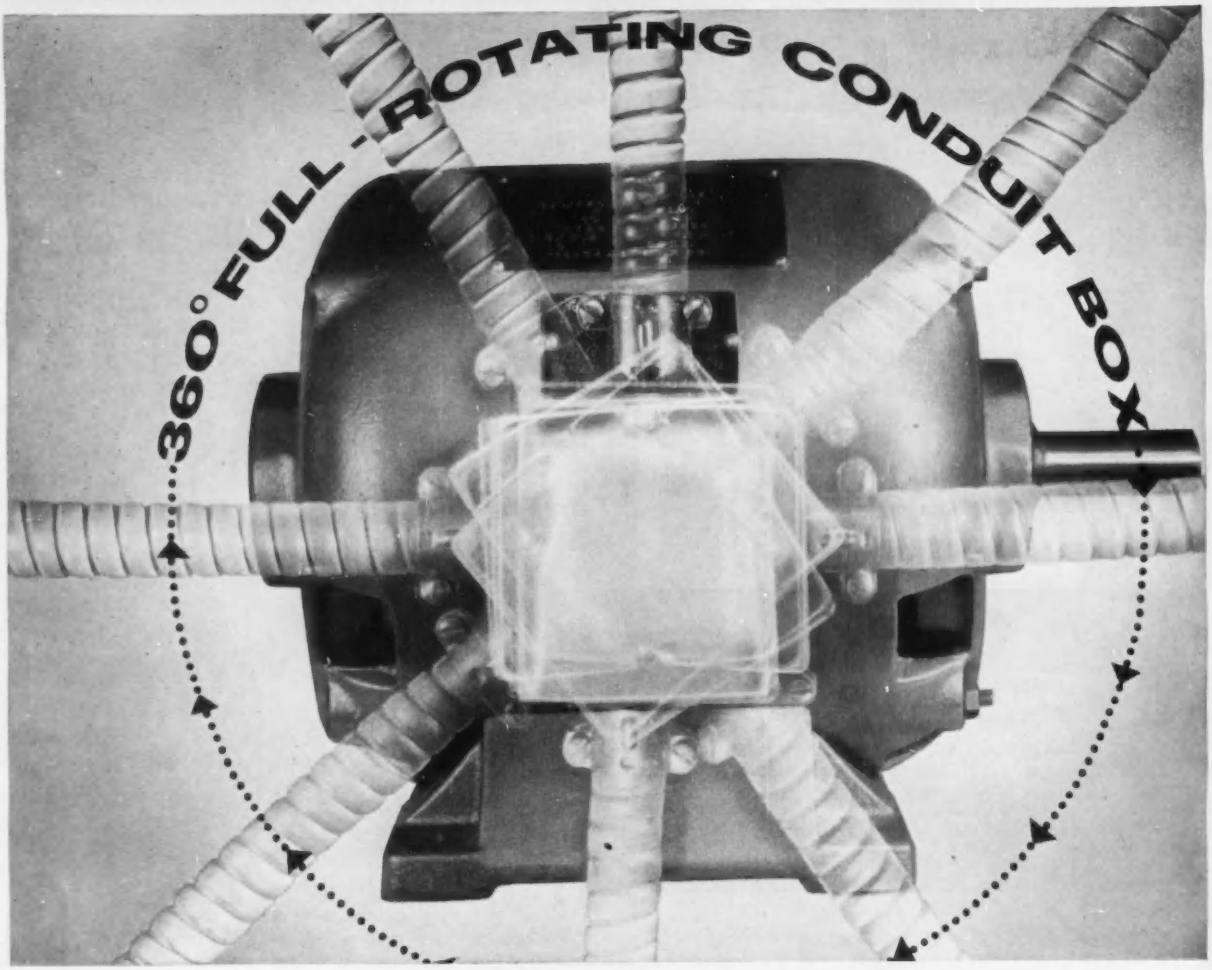
FORGING INGOTS and BILLETS

PLATES

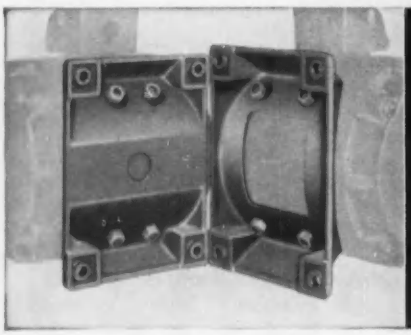
SHARON STEEL CORPORATION *Sharon, Pennsylvania*

District Sales Offices: Chicago, Cincinnati, Cleveland, Dayton, Detroit, Grand Rapids, Indianapolis, Los Angeles, Milwaukee, New York, Philadelphia, Rochester, San Francisco, Seattle, Montreal, Que., Toronto, Ont.

EXCLUSIVE in

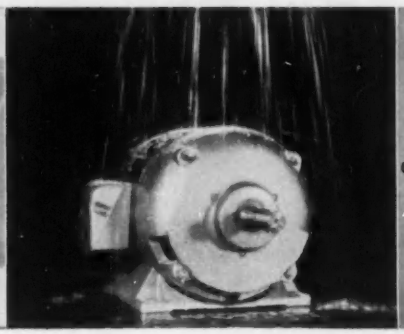


You get these quality A. O. Smith motor features...



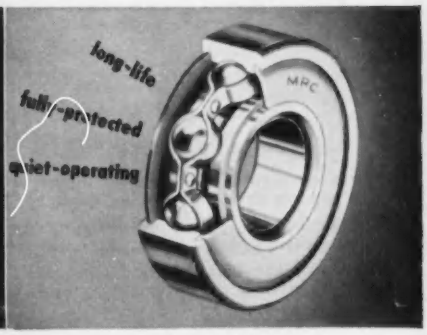
OPTIONAL FRAME MOUNTINGS

There's no need to change product design to use new NEMA frame sizes. A. O. Smith gives you frame mountings drilled to old and new specifications.



DRIP-PROOF CONSTRUCTION

Motor can be mounted in any position . . . drip-proof thru 360° cycle . . . simply rotate end brackets. No foreign matter can enter vent holes.



PRE-LUBRICATED BEARINGS

Shielded bearings assure protection against over greasing . . . provide even load distribution under all working conditions . . . quiet operating.

A. O. Smith integral hp motors

Saves space... speeds motor installation... convenient design for easy connection of leads

JUST one example of the many exclusive features you get with A. O. Smith integral hp motors is the full-rotating conduit box. This advance design permits you to connect terminal leads from any angle without re-positioning the motor once it's installed.

The conduit box may be rotated through a full 360° by simply removing the cover and loosening three screws. And a special gasket is used to seal out the moisture... no chance for corrosion, a major cause of power failure.

It's good business to specify A. O. Smith integrals, because you get motors that are application-engineered to match the performance and quality of your product. You can say goodbye to the problem of adapting your product to the design limitations of conventional motors.

And remember — for your design or speed requirements, there's an A. O. Smith integral hp motor available to power your products. Integrals are built in single-phase (1-7½ hp) and polyphase (1-150 hp)... in various speeds and frequencies... choice of frame mountings for either old or new NEMA dimensions... C and D flanges as required.

Produced by one of America's great industrial concerns, these motors are backed by a national network of 270 strategically located factory service stations. There's one near you — ready to provide 24-hour service on all parts and service orders.

For more information on A. O. Smith integral hp motors, write for new Bulletin No. EM156.

Through research ... *a better way*

A.O.Smith

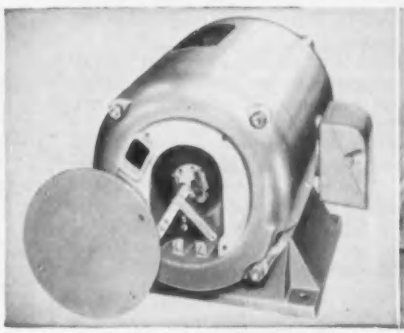
CORPORATION

ELECTRIC MOTOR DIVISION

TIPP CITY, OHIO

International Division: Milwaukee 1, Wisconsin

application-engineered to match your product requirements

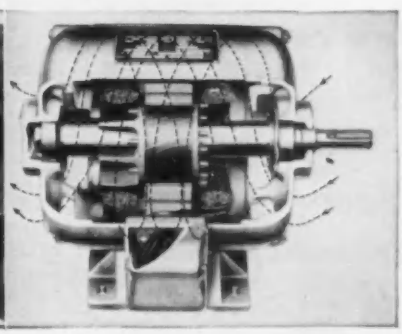


SEALED STARTING SWITCH AND ACTUATOR

Exclusive development... totally-enclosed in end frame. No need to remove motor from line for switch service.

DYNAMICALLY-BALANCED ROTOR

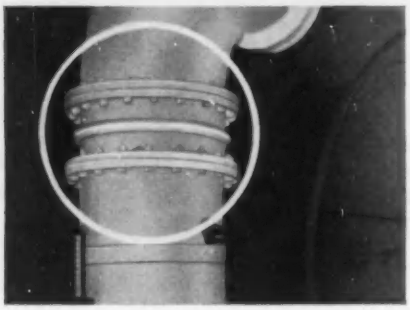
Assures continuous, vibrationless, trouble-free performance and maintains long bearing life. Indestructible laminations are high-quality silicon steel.



CONTROLLED THRU-VENTILATION

Cooling system designed for high-volume, low velocity air for maximum heat transfer. Temperature held to absolute minimum, assuring longer insulation life.

How long can a U. S. Rubber Expansion Joint last



...some have been on the job since 1926, the year they were invented!

Here are just a few reasons why *these flexible connections are used in pressure or vacuum pipe lines...*

- U. S. Rubber Expansion Joints are resilient and, therefore, do not, like metal, set permanently when compressed.
- Constant flexing merely keeps "U. S." joints "alive"...prevents them from becoming brittle.
- They absorb both axial *and* lateral deflection far more than metal joints. Greater insulation against vibration and pump noises is provided.
- There is never any electrolysis, corrosion or erosion.
- U. S. Rubber joints handle pressures from 40 lbs. to 125 lbs. Compare!
- The outside diameter of the arch is smaller than that on metal joints. Face-to-face dimensions (even with multiple arches) are smaller.
- Weight is much less. This, plus the fact that no gasket is needed between flanges (unlike metal joints) results in a more easy installation, lowering the cost.

"U. S." was the first to develop rubber expansion joints. They are at work in every kind of industry, prolonging the life of equipment in pressure or vacuum pipe systems. Obtainable at any of the 28 "U. S." District Sales Offices, or write us at Rockefeller Center, New York 20, N. Y.

US RUBBER

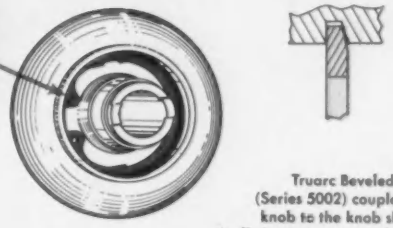
Mechanical Goods Division

United States Rubber

Waldes Truarc Retaining Rings Eliminate Machining— Provide Stronger Assembly, Greater Accuracy

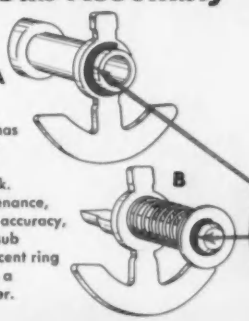
The American Hardware Corp., New Britain, Conn., uses 4 different types of Waldes Truarc Retaining Rings in the original design of these famous Corbin and Russwin Heavy Duty Cylindrical Locks. Truarc rings improve product performance, eliminate rejects, and cut labor costs.

Knob Sub Assembly



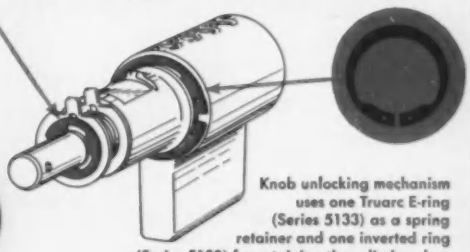
Truarc Beveled Ring (Series 5002) couples the knob to the knob shank. It eliminates two tapped holes and two screws, provides stronger assembly and greater accuracy. Beveled ring takes up end play rigidly.

Spindle Sub Assembly



Spindle sub assembly "A" has two Waldes Truarc crescent rings (Series 5103) used as locating flanges for rollback. This saves labor and maintenance, improves performance and accuracy, eliminates rejects. Spindle sub assembly "B" uses one crescent ring as a spring retainer and as a locating shoulder for washer.

Cylinder Sub Assembly



Knob unlocking mechanism uses one Truarc E-ring (Series 5133) as a spring retainer and one inverted ring (Series 5108) for retaining the cylinder plug. Rings are re-usable in the event of disassembly for maintenance. Rejects are eliminated.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product...to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types...as many as 97 different sizes within a type...5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U.S.A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today...let our Truarc engineers help you solve design, assembly and production problems...without obligation.

For precision internal grooving and undercutting...Waldes Truarc Grooving Tool!

Send for new catalog supplement

WALDES

TRUARC®

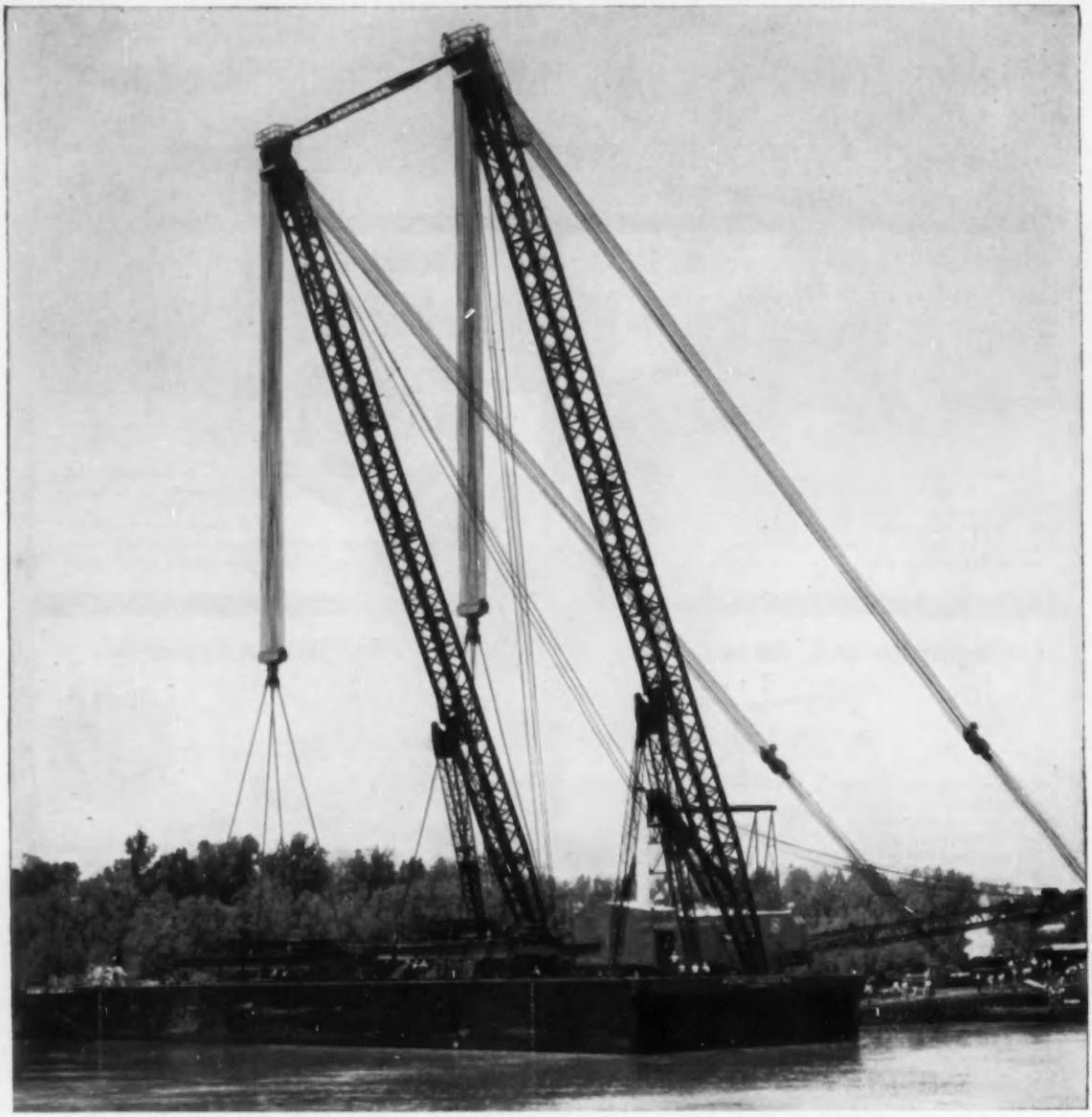
RETAINING RINGS

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
(Please print)

*Name*_____
*Title*_____
*Company*_____
*Business Address*_____
*City*_____ *Zone*____ *State*_____

PN048

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.



Sheerleg derrick built of Mayari R by American Hoist & Derrick Co., St. Paul, and assembled by Avondale Marine Ways, New Orleans.

Mightiest derrick in the world

Quite a rig, this big sheerleg derrick. Built for use in erecting offshore drilling platforms, she's taller than a 20-story building and requires a special 300-ft barge to keep her on an even keel!

And strong? When they tested her muscles recently in the Gulf of Mexico, she hoisted a deadload of 800 tons, setting a new world's record, nearly doubling the previous record by the block-and-fall method!

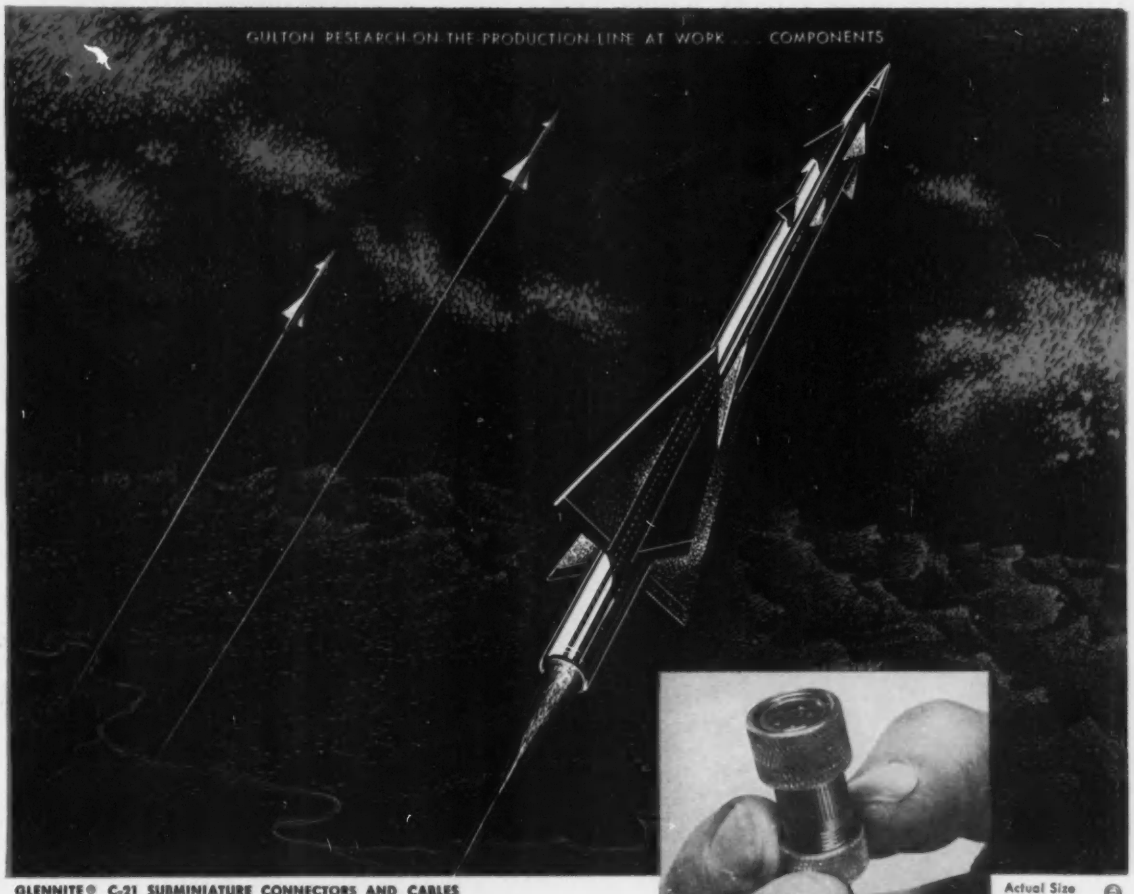
It is significant that the makers of this giant, American Hoist and Derrick Company, fabricated the sheerlegs from Mayari R high-strength, low-alloy steel. Mayari R is 50 pct stronger than carbon structural steel, five to six times more corrosion-resistant, and fully as weldable. For the full story on Mayari R, write for Catalog 353.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

Mayari R...High-Strength, Corrosion-Resisting Steel



GLENNITE® C-21 SUBMINIATURE CONNECTORS AND CABLES

Actual Size

Born at 40,000 FEET under severe vibration...

Gulton Industries' Research-on-the-Production-Line makes possible instant tailoring of basic materials, instruments or complete systems to fill difficult or unusual requirements.

THE PROBLEM: Sensitive instruments in today's missiles and aircraft are constantly being made smaller and smaller to conform to **exacting** space requirements. To carry back the vital information sensed by these instruments, a **completely unique type** of connector and cable was required . . . . . extra ruggedness, superior shock and vibration characteristics had to be combined with minimum size and weight. Nothing with **all** the necessary qualities existed!

THE SOLUTION: Gulton engineers concentrated their unconventional approach and long years of experience in shock and vibration research on answering this problem . . . the result: new subminiature GLENNITE C-21 Connectors and Cables.

Only ¼ the size and weight of comparable AN types (.565" O. D.—1" length), advance-design C-21 Connectors have a revolutionary, internal cable clamp, special free-floating pins and provision for cable coiling that prevent transmission of shock to the connector housing . . . C-21 Units withstand up to 25 lbs. cable tension **without effect!** And positive keying and polarization prevent incorrect assembly, **even if key is damaged** . . . they are available in a wide selection of styles and pin arrangements . . . each type has a matching C-21 Cable.

For complete technical information on GLENNITE Connectors and Cables or Gulton Industries' Electronic Systems, write for Catalog # 901 today!

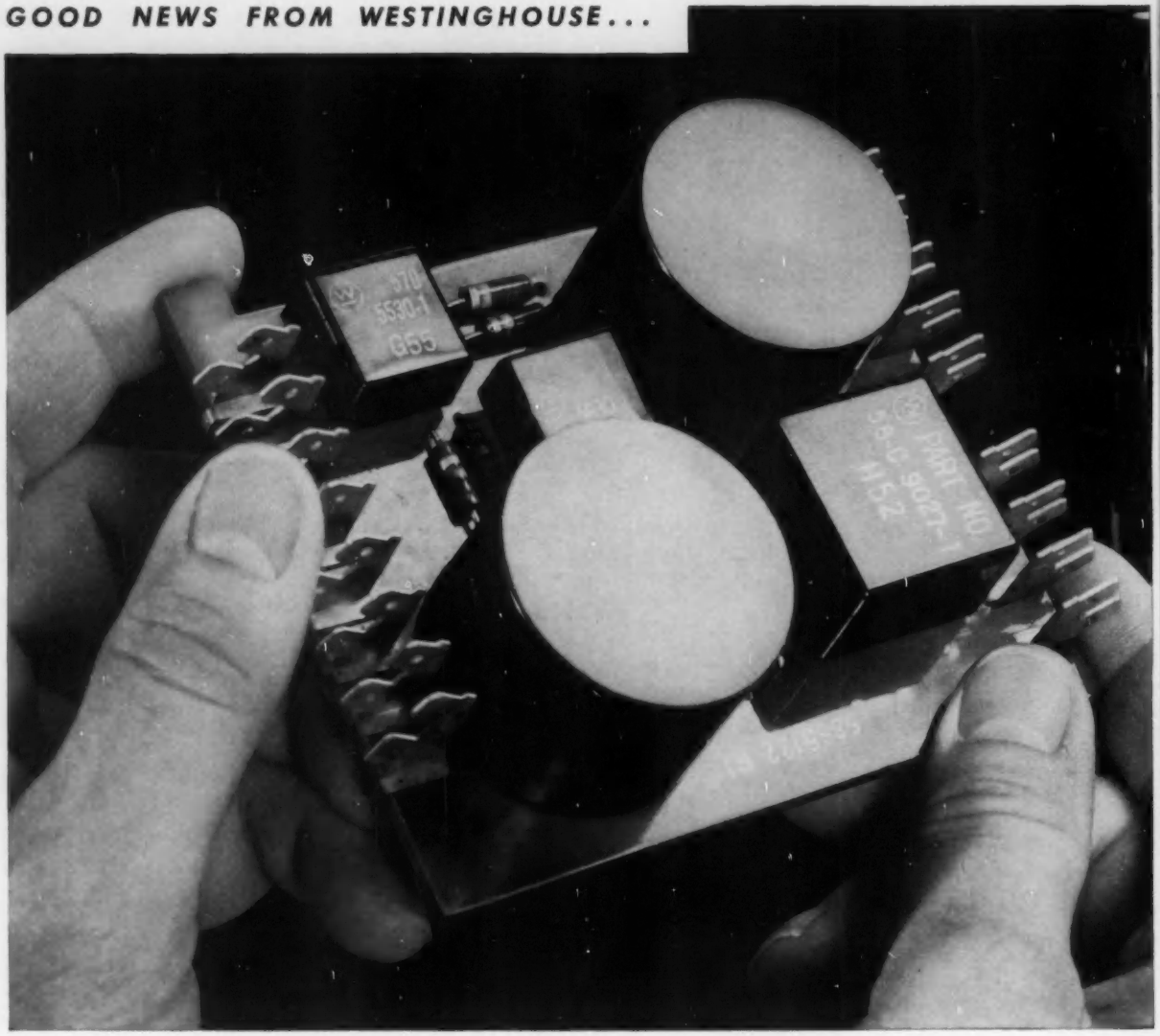
GULTON MFG. CORP.

GULTON INDUSTRIES, INC.

associated with **GULTON INDUSTRIES, INC. Metuchen, New Jersey**

PIONEERS IN MATERIALS RESEARCH, ELECTRONIC COMPONENTS, PRECISION INSTRUMENTS AND SYSTEMS ENGINEERING

GOOD NEWS FROM WESTINGHOUSE...



THIS IS CYPAK*

the most revolutionary industrial control advance in 25 years

Just two years ago, production and control engineers alike dreamed of the possibilities of a relay with no moving parts. A reality today, Westinghouse CYPAK introduces static control from units that fit the palm of your hand. CYPAK control has no moving parts to wear, corrode, jam or otherwise cause failure. In addition, CYPAK refines the relay art through making use of basic logic functions.

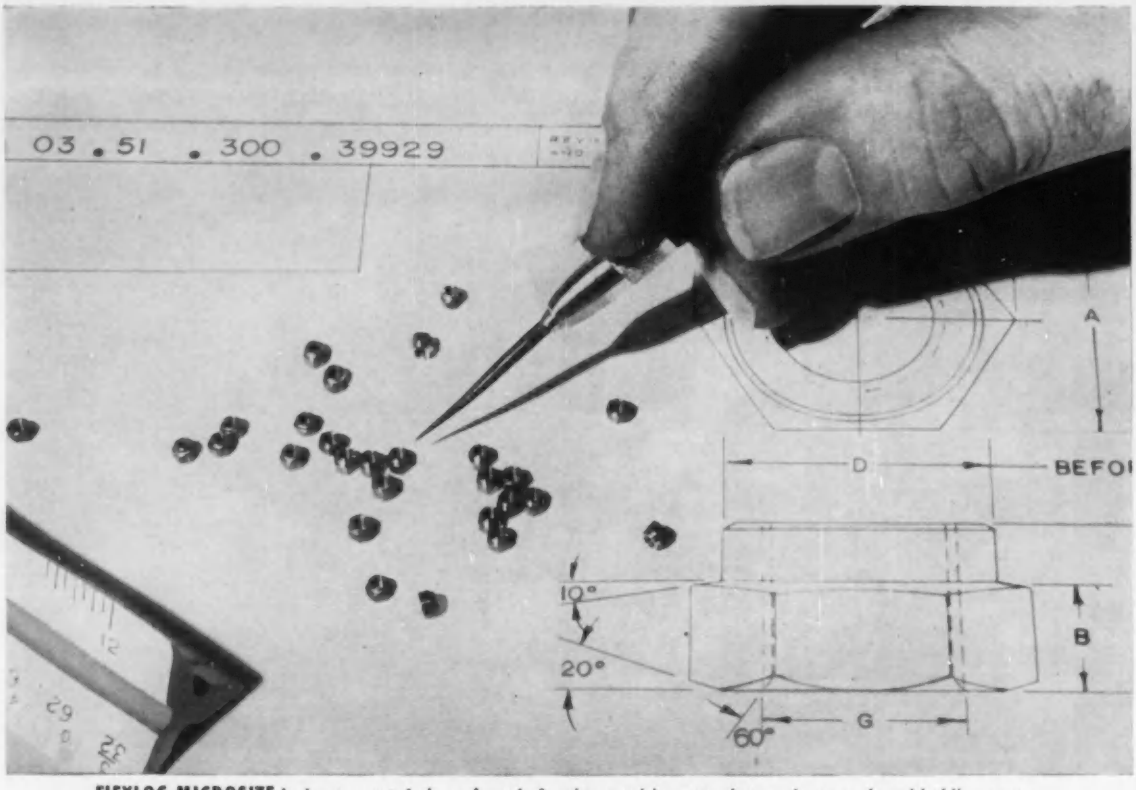
The result—static control with life at least 15 times that of conventional relays. While twenty million open-close cycles is usually the maximum life of a mechanical relay, CYPAK systems can handle that many cycles in days without a trace of fatigue.

Besides eliminating maintenance and down time, CYPAK opens new opportunities for broader, more complex control. Look into these advantages of CYPAK by calling your Westinghouse sales engineer. J-01002

* Trade-Mark

Write today for your free copy of *The Whys and Wherefores of* CYPAK, Booklet B-6584. Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pa.

YOU CAN BE SURE...IF IT'S Westinghouse



FLEXLOC MICROSIZE locknuts meet designers' needs for tiny precision nuts that retain strength and holding power in the smallest assemblies—servomechanisms, electronic and electrical equipment, all miniature devices.

Design Lighter, More Compact Products with New FLEXLOC Microsize Locknuts

Standard Microsize Locknuts Permit Design Engineers to Develop and Fasten Smaller Assemblies Safely

SIZE	Across Flats		Shoulder Height		Across Corners	Height +.000 −.003
	MAX.	MIN.	MAX.	MIN.	MIN.	
0-80 NF-3B	.111	.107	.047	.042	.123	.075
1-64 NC-3B	.127	.123	.0635	.0585	.141	.090
1-72 NF-3B	.127	.123	.0635	.0585	.141	.090
2-56 NC-3B	.158	.153	.068	.063	.176	.105
2-64 NF-3B	.158	.153	.068	.063	.176	.105
3-48 NC-3B	.190	.183	.071	.066	.210	.120
3-56 NF-3B	.190	.183	.071	.066	.210	.120
4-40 NC-3B	.190	.183	.072	.067	.210	.120
4-48 NF-3B	.190	.183	.072	.067	.210	.120

STANDARD MICROSIZE FLEXLOCs—in sizes ranging from 0-80 to 4-48—are available in brass (either plain or cadmium plated). Consult SPS for miniature nuts of other conventional materials.

New FLEXLOC Microsize locknuts are smaller and lighter than regular FLEXLOCs of the same nominal diameter. Wrenches of smaller size are used to install them. Mating joints or flanges can be designed smaller—with no loss in strength or convenience of assembly.

Microsize FLEXLOCs have all the advantages of larger FLEXLOCs. One-piece, all-metal construction—nothing to put together, come apart, lose or forget. Use them as lock or stop nuts—they stay put anywhere on a threaded member as soon as the locking threads are fully engaged. Uniform locking torques insure accurate preloading. There are no nonmetallic inserts to pop out or deteriorate. Moisture, dryness, oil, temperatures to 250°F won't affect these Microsize FLEXLOCs. Just screw them on. They lock and stay locked. Vibration won't shake them loose.

For complete information on Microsize FLEXLOCs, consult your authorized SPS distributor. Or write STANDARD PRESSED STEEL CO., Jenkintown 28, Pa.

STANDARD PRESSED STEEL CO.

FLEXLOC LOCKNUT DIVISION SPS

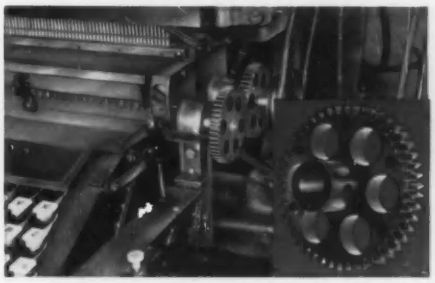
JENKINTOWN PENNSYLVANIA

DU PONT
REG. U.S. PAT. OFF.
Better Things for Better Living ... through Chemistry

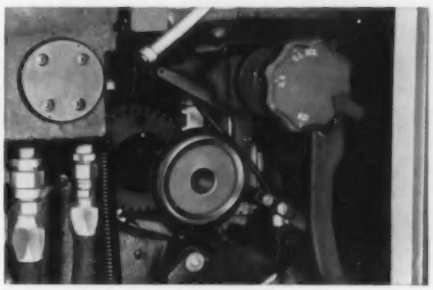
PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

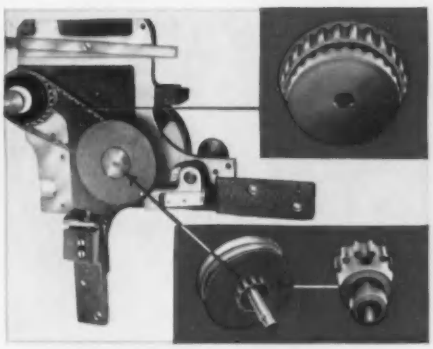
Parts of ZYTEL® nylon resin outperform conventional materials in six linotype machine applications



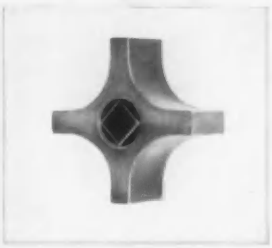
Gears for rubber keyboard rolls
Gears of "Zytel" are noiseless, require no lubrication and show no wear, even after years of service. These parts were formerly made of cast iron.



Selector handle control knob
"Zytel" reduces weight and inertia—gives better appearance and "feel" than the conventional material it replaced.

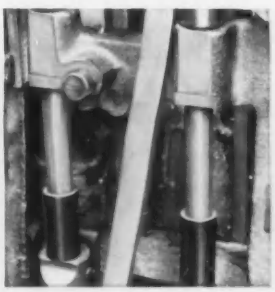


Assembler pulley and star sprocket
Molded "Zytel" cuts the expense of specially shaped teeth on parts formerly made of steel, gives top wear resistance.



Assembler star
Replacement was more frequent when this part was made of a fiber material. "Zytel" withstands the constant friction and impact; costs less to manufacture.

Matrix buffer
"Zytel" replaces fiber material in this part, offering three times the working life and reducing the cost substantially.



Stop sleeves
Subjected to heavy impact, these sleeves are now made of "Zytel". They offer the advantages of closer dimensional control in manufacture and reduction of noise in operation.

Du Pont "Zytel" offers superior strength, abrasion resistance and resiliency

ON THE highly-complicated, fast-running linotype machine, Du Pont "Zytel" has proved extremely valuable as an engineering material. Molded parts of "Zytel" have helped the manufacturer of the machine, Mergenthaler Linotype Company, to achieve better performance at lower cost.

On this type of machine, many parts are constantly in motion and subject to wear. Molded parts of "Zytel" have shown their ability to stand up under the most rugged service. They have exhibited unusual wear resistance and impact strength, helped to reduce noise, eliminate the need for lubrication wherever they are used.

Molded parts of "Zytel" have proved less expensive to manufacture than parts made of other materials. Also, parts of "Zytel" can be colored for easy identification by maintenance men.

To date, six kinds of parts molded of "Zytel" have been installed on the linotype machine. All of these are shown at the left. Much wider use of this engineering material is currently being planned by the machine manufacturer.

"Zytel" is distinguished by its toughness, form stability at high temperatures, and chemical resistance. It has high hardness value, together with a low coefficient of friction, which contribute to its excellent abrasion resistance.

Can "Zytel" help solve a design problem for you? Clip and mail the coupon for more information.

OVER

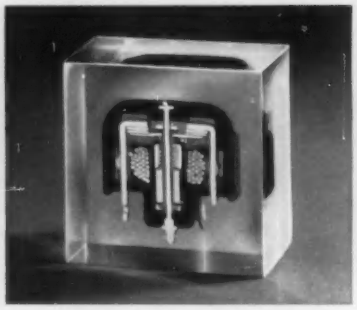
DU PONT

Better Things for Better Living ... Through Chemistry

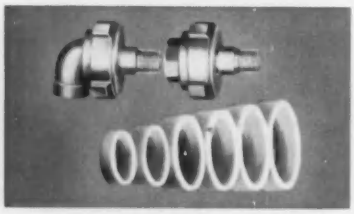
PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

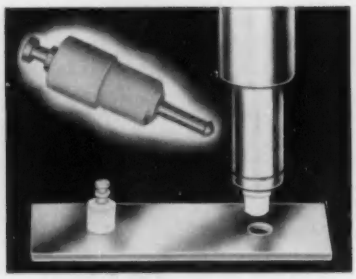
5 examples of how Du Pont engineering materials help solve design problems



LUCITE® acrylic resin adds beauty and durability to embedments, which have a variety of uses. Small items such as electrical components or intricate mechanisms, as well as miniatures of larger products, can be embedded in the "Lucite" either singly or in patterns giving exploded-view effects. These miniature sales showcases can be handled indefinitely without growing grimy and losing their functional and promotional value. (Embedments shown made by Plastic Developments, Inc., Attleboro, Mass.)



TEFLON® tetrafluoroethylene resin in gaskets for swivel joints is without equal for long wear and trouble-free service. Joints maintain their seal under the most adverse conditions. They excel in steam service, perform uniformly within the temperature range of −50°F. to 450°F., are smoother, tougher, and longer wearing—no lubrication ever needed. (Swivel joints by Barco Manufacturing Co., Barrington, Illinois)



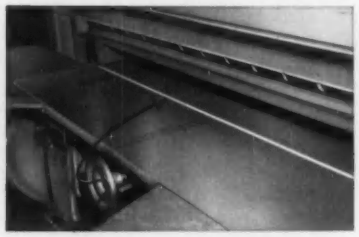
TEFLON® tetrafluoroethylene resin is utilized in miniature and subminiature stand-off and feed-through terminals. They cost less than conventional glass or ceramic terminals, and they offer further economy in reduced labor and assembly time.

These terminals of "Teflon" are of a molded, one-piece construction, and can be simply and permanently mounted into chassis holes by press-fitting, using an inexpensive insertion tool. The resiliency of "Teflon" enables these terminals to be pressed in place for rigid and permanent installation without requiring any soldering operations or any other hardware.

The superior electrical, mechanical and chemical properties of "Teflon" further increase the range of application for these miniature terminals. They are tough and remain resilient over a temperature range of −100°C. to 250°C. Dielectric strength of "Teflon" is high over a considerable temperature range. "Teflon" is chemically inert to any known solvents, acids or bases. Terminals can be used in military equipment for tropical use, without additional fungicidal treatment. Terminals will not melt, burn or char. ("Press-Fit" terminals manufactured by the Sealectro Corp., New Rochelle, N.Y.)

These applications are typical of the product improvements made possible when design and service requirements are evaluated in terms of the properties of these unique engineering materials. For further information, mail the coupon below.

ZYTEL® nylon resin is the only material used in the Nylon-Maid shower heads. The inherent chemical resistance of "Zytel" enables these shower heads to function without danger of corrosion. They are easily installed and adjusted. Shower heads of "Zytel" are tough, resilient, and heat-resistant. They offer years of trouble-free service. (Shower heads by Nylon-Maid, Inc., Glendora, California. Parts of "Zytel" by Rainbow Plastics, El Monte, California.)



ALATHON® polyethylene resin has replaced wood in the sticks which act as a knife stop for this paper cutter. The life of "Alathon" is six times greater than that of wood, and tests have shown that the cutting knife will last twice as long when "Alathon" is used. It provides savings in costs and down time. (Cutting stick by Cefaly Experimental Co., Inc., Brentwood, Maryland.)

Investigate Du Pont engineering materials in your product development programs

One of the family of these versatile engineering materials is often a key factor in product improvement or new product design. The wide range of properties available with "Alathon"* polyethylene resin, "Lucite"* acrylic resin, "Teflon"* tetrafluoroethylene resin, and "Zytel"* nylon resin are helping solve industrial design problems.

NEED MORE INFORMATION? Clip the coupon for additional data on the properties and application of these Du Pont engineering materials.

E. I. DU PONT DE NEMOURS & CO. (Inc.) POLYCHEMICALS DEPARTMENT
Room 104, Du Pont Building, Wilmington 98, Delaware.
In Canada: Du Pont Company of Canada, Ltd., P. O. Box 660, Montreal, Quebec.

Please send me more information on the Du Pont engineering materials checked: ☐ *"Zytel";* ☐ *"Alathon";* ☐ *"Teflon";* ☐ *"Lucite". I am interested in evaluating these materials for:*

NAME _____ POSITION _____

COMPANY _____

STREET _____

CITY _____ STATE _____

TYPE OF BUSINESS _____

*"Alathon", "Lucite", "Teflon" and "Zytel" are registered trade-marks of E. I. du Pont de Nemours & Co. (Inc.)

Don't Let These Filing Bottlenecks Stall Drafting Room Output!

File units for roll tracings are available. Individual trays protect each roll from dirt, tearing, and crushing.

Let Your Bruning Man Show You How a Hamilton UnitSystem

Saves Space and Time, Permits Orderly Expansion

UnitSystem is Integrated to Save Time and Space. UnitSystem offers you an integrated and interlocking stack in which your drawings and records are filed in units especially designed for them by size and frequency of use. Drawings are easier to file and find, which saves time. The interlocking feature lets you combine the individual units you need—in higher stacks—which saves space.

The Shallow-Drawer Unit with special tracing lifters makes any active tracing easily accessible without risk of damage to companion tracings. Vertical Filing Unit with index binders and compressors keeps active small sheets straight and upright without wrinkling or tearing. Five-Drawer Unit provides ideal storage for semi-active or inactive drawings and records by groups or projects.

UnitSystem is Expandable for Future Needs. Because all UnitSystem files in the same line number are matched and interlocking, you expand your filing set-up gradually, efficiently, and economically. From a complete line of units, you choose those that exactly meet your requirements as they arise.

Mail coupon today for more information on the important savings offered you by lifetime all-steel UnitSystem files.

Ask your Bruning representative for information about the Bruning-Hamilton free analysis and planning service for improving your filing system—or use coupon below. No obligation.

BRUNING

America's Leading Supplier of Engineering and Drafting Equipment

Charles Bruning Company, Inc., 4700 Montrose Ave., Chicago 41, Illinois

In Canada: Charles Bruning Company (Canada) Ltd., 105 Church St., Toronto 1, Ont.

Charles Bruning Company, Inc., Dept. 44-O
4700 Montrose Avenue, Chicago 41, Illinois

☐ Please send me information on Hamilton UnitSystem.

☐ Send me information on the Bruning-Hamilton free analysis and planning service.

Name_____ Title_____

Company_____

Address_____

City_____ County_____ State_____

Still in excellent condition after 37 months. One of three nickel steel pinions from the 43" blooming mill of United States Steel Corporation at Youngstown is ready for more gruelling work. Previous pinion life was 5½ months.

3,500,000 tons of steel...their output

Nickel steel pinions excellent after 3 years' use where predecessors averaged 5½ months

WORKING 37 MONTHS without interruption in a 43" blooming mill, three pinions cast in nickel alloy steel produced more than seven times the output of previous pinions . . . and were still in excellent condition.

This performance . . . in a United States Steel Corporation plant . . . reflects the high level of performance offered by cast steel containing nickel.

Producer of the nickel steel pinions, Mackintosh-Hemphill Division of E. W. Bliss Company, Pittsburgh, Pa., cast them in a 3½% nickel, medium carbon steel. Heat treatment developed the following physical properties:

Tensile Strength psi, min.	100,000
Yield Point, psi.	70,000-80,000
Elongation % in 2"	25-20
Reduction of Area, %	50-45
Charpy V-Notch Impact, ft.-lb.	20-17
Hardness, Shore	34

The properties of nickel alloys may be controlled to meet both fabricating and service demands. So when you need a metal for improved performance and fewer replacements . . . let's talk it over. A nickel alloy may offer exactly what you want.

Write for . . . "List A" of available publications. It includes a simple form that makes it easy to outline your problem for our study.

INCO

THE INTERNATIONAL NICKEL COMPANY, INC. 67 Wall Street New York 5, N.Y.

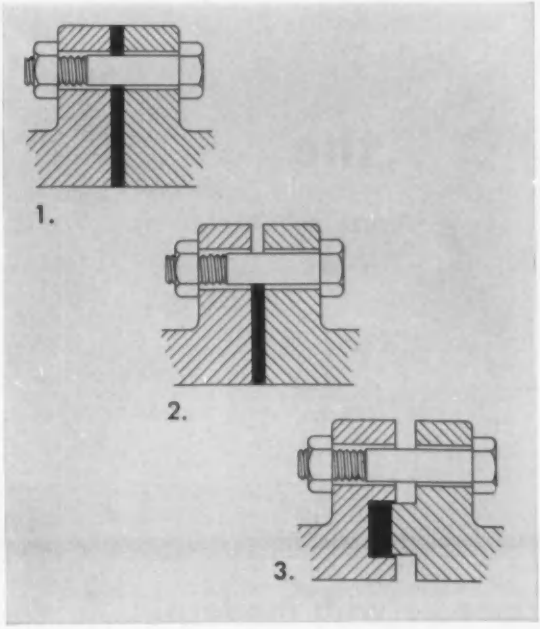
How to select gasket materials for use in basic joints

Many factors affect the choice of a gasket material. Cost, temperature involved, fluid action, flange surface characteristics, unit load or compression, and internal pressure, all must be considered. However, the first question to be answered is, "What general type of material is suitable in this particular flange?"

common flange joints

A simple flange (Fig. 1) may be sealed with nearly any kind of flat gasket, plain or jacketed. Ordinarily, however, fiber sheet, cork composition, cork-and-rubber, and similar materials are best. Straight rubber, on the other hand, tends to extrude from such a joint under medium to high flange pressures.

By reducing the gasket wall section of the simple flange (Fig. 2), a higher load is placed on the gasket without changing the bolt pressure. The flange will thus retain

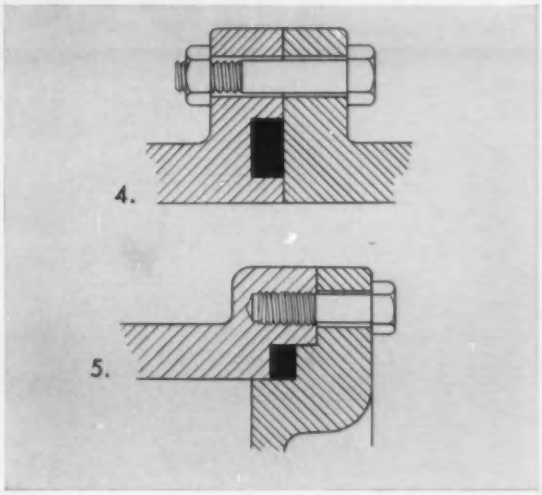


higher internal pressures—and gasket cost may be reduced. Again, nearly any type of flat gasket is suitable, but in this case the tendency of rubber to extrude is emphasized by the increased unit loading.

A further variation of the common flange joint is the tongue-and-groove (Fig. 3), used where extremely high pressures on the gasket are needed to retain high internal pressures. It, too, may be sealed by nearly any type of flat gasket. Here, the incompressibility of straight rubber is not a problem because the gasket is completely confined. Since rubber will deform but not compress, however, a rubber gasket should be cut so that it does not fill the channel and prevent the tongue from entering the groove.

metal-to-metal joints

In metal-to-metal joints (Figures 4 and 5), rectangular-section rubber gaskets may be used effectively if their



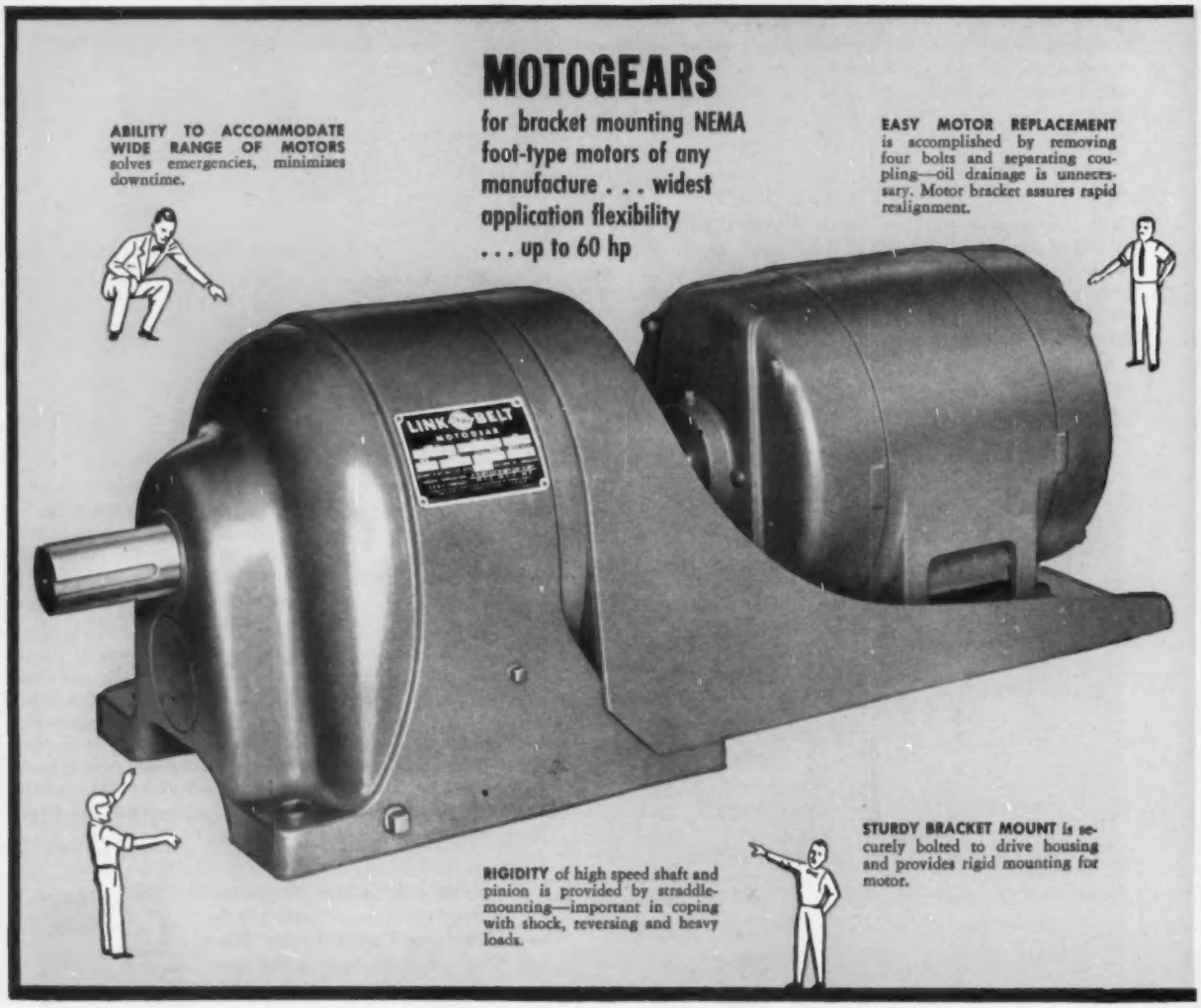
volumes and shapes are correct. That is, gasket volume cannot exceed the volume of the cavity or the joint will not close. At the same time, the shape of the gasket must permit about 25 per cent deflection of the gasket when the joint is closed. When very close gasket tolerances are impractical, the gasket can be cut larger than the cavity if relief for sideflow is provided in the joint design.

A simpler solution to gasketing a metal-to-metal joint, however, is to use truly compressible materials such as cork composition or cork-and-rubber. With these materials, gasket volume and shape are not critical. Cork composition, for instance, can be cut to full channel width and twice the depth, yet it will compress into the cavity and permit perfect mating of the metal surfaces. Cork-and-rubber materials also combine the advantage of compressibility with the sealing properties of synthetic rubber.

You'll find other useful information on the design and use of gaskets in the new Armstrong Gasket Design Manual. Write for your copy of this manual to Armstrong Cork Company, Industrial Division, 7104 Irvin Street, Lancaster, Pennsylvania.

Armstrong
GASKET MATERIALS
. . . used wherever performance counts

LINK-BELT announces MOTOGEARS and


MOTOGEARS
for bracket mounting NEMA foot-type motors of any manufacture . . . widest application flexibility . . . up to 60 hp
ABILITY TO ACCOMMODATE WIDE RANGE OF MOTORS solves emergencies, minimizes downtime.
EASY MOTOR REPLACEMENT is accomplished by removing four bolts and separating coupling—oil drainage is unnecessary. Motor bracket assures rapid realignment.
LINK-BELT
MOTOGEAR
RIGIDITY of high speed shaft and pinion is provided by straddle-mounting—important in coping with shock, reversing and heavy loads.
STURDY BRACKET MOUNT is securely bolted to drive housing and provides rigid mounting for motor.

★ *Years-ahead design* — to harmonize with modern NEMA motors

★ *Stamina for the years ahead* — combining utmost compactness and highest efficiency for heavy-duty service

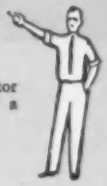
line of New, COMPACT GEARMOTORS...

GEARMOTORS

the ultimate in compactness . . . with flange-mounted NEMA motors . . . up to 30 hp

UTMOST COMPACTNESS is provided by flanged connection of motor to gear drive.

BUILT-IN ALIGNMENT of motor is provided through use of a rabbet-fit motor flange.



ONE-PIECE HOUSING cuts maintenance, offers added strength and assures oil-tight, quiet operation.

NEVER before has a speed reduction line offered this combination of features: *oil-tight design* having a minimum number of openings, each protected by an effective oil seal; *quiet operation* resulting from precision machining and noise-absorbing, cast iron housing; *standardization* with only one low-speed gear set per drive size; *compactness* derived from a unique gear arrangement; *integral backstop* with positive-locking action, which may be installed at any time. Learn all about these advanced new drives—ask your Link-Belt office or authorized stock-carrying distributor for Book 2447.

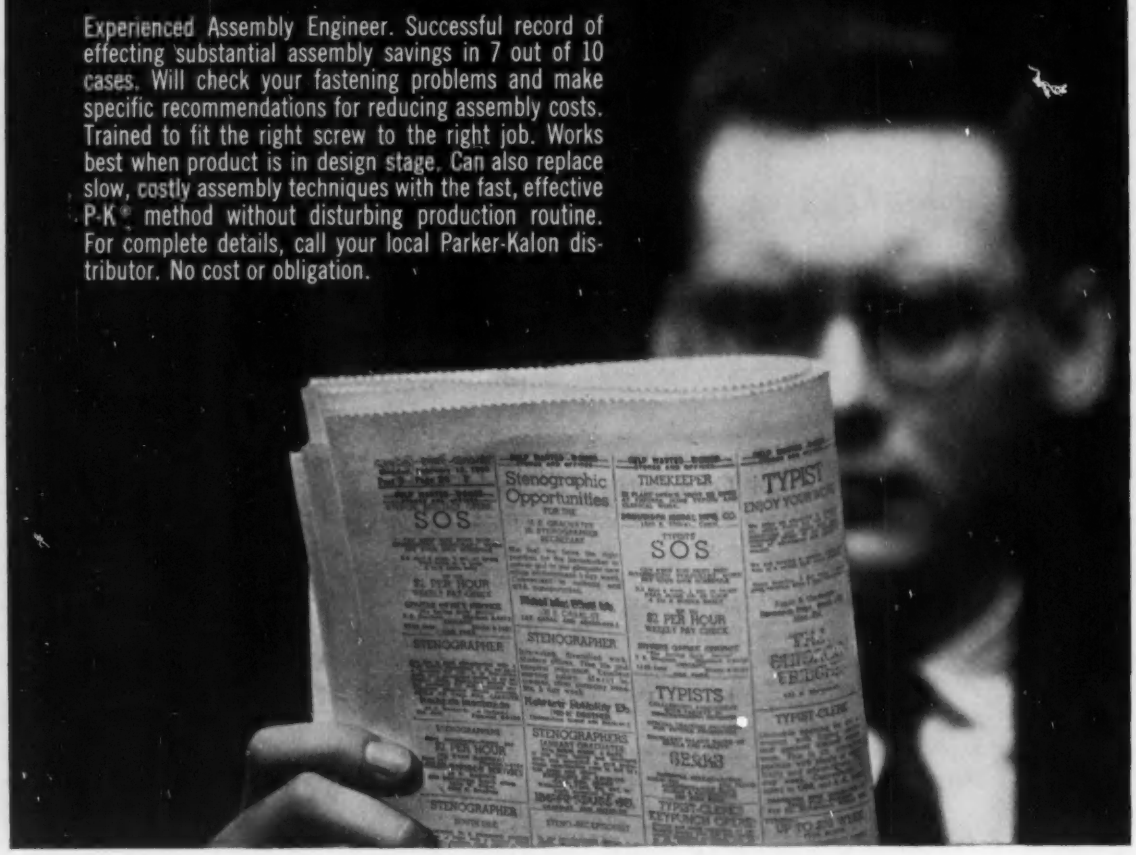
LINK-BELT

ENCLOSED DRIVES

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13,107

JOB WANTED

Experienced Assembly Engineer. Successful record of effecting substantial assembly savings in 7 out of 10 cases. Will check your fastening problems and make specific recommendations for reducing assembly costs. Trained to fit the right screw to the right job. Works best when product is in design stage. Can also replace slow, costly assembly techniques with the fast, effective P-K® method without disturbing production routine. For complete details, call your local Parker-Kalon distributor. No cost or obligation.



this specialist wants to work for you!

Call in a P-K Assembly Engineer and find out how you can profit through reduced assembly costs the P-K way. Take advantage of this unique Parker-Kalon service—another of the many reasons why users say—"if it's P-K . . . it's O. K."

PARKER-KALON DIVISION, GENERAL AMERICAN TRANSPORTATION CORPORATION—CLIFTON, NEW JERSEY

PARKER-KALON® *fasteners*

Sold Everywhere Through Leading Industrial Distributors. Warehouse in Chicago, Illinois

Mr. Designer:
Don't give up that
bold idea until
you talk to "U. S."
Molding experts

With U. S. Molded & Engineered Products, designers find they can do things impossible with any other material. Problems in flexing, in product thickness, in uniformity and consistency—*no matter how high your production quota* —all become far easier or disappear entirely. The designer, free of the shackles imposed by other materials, can set his sights for exciting new horizons in design and construction.

"U. S." expertly molds rubber with any or all of these important properties: compression recovery... resistance to acid, various chemicals, oil, water... hot or cold tear-resistance... required tensile strength and elongations.

"U. S." factory-trained engineers will help you solve any molded rubber problem. Contact United States Rubber, Mechanical Goods Division, Rockefeller Center, New York 20, New York.

US RUBBER

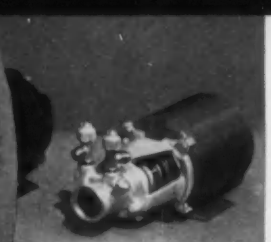
Mechanical Goods Division

United States Rubber

Have you evaluated your

TRIANGLE MFG. CO.
"cut costs 15%"

GAST MANUFACTURING CORP.
"30% lighter, but performs better"



ROWE SPACARB, INC.
"saved $3 per unit"

AMERICAN-STANDARD
"cut product size and weight"

PACIFIC PUMPING CO.
"helped double sales"

DECORA MFG. CO.
"saved 40¢ per unit on shipping"

SWEDEN FREEZER MFG. CO.
"most dependable motor"

AIRCRAFT-MARINE PRODUCTS, INC.
"extremely low service expense"

DEMING COMPANY
"saved on handling and shipping"

motor savings yet?

AMERICAN BLOWER CO.
"reduced motor stocks"

A. B. DICK CO.
"much more value for your money"

UNIVERSAL INDUSTRIES
"helped make peeler portable"

FINNELL SYSTEM, INC.
"100% standardized on G.E."

TODAY THOUSANDS OF COMPANIES CUT COSTS, BOOST QUALITY WITH ADVANCED G-E MOTORS

In the past four years, equipment manufacturers have bought nearly 5,000,000 smaller, lighter G-E fractional-hp motors. Today, they testify to the ***tangible, measurable benefits*** they have realized. For example:

MANUFACTURING AND SHIPPING SAVINGS amounting to about 15% resulted from a Detroit pump manufacturer's* decision to switch to advanced-design G-E motors. Rugged construction of the G-E motor permitted direct mounting, eliminated several parts. Lighter weight reduced worker fatigue, helped speed assembly—shipping and packaging savings alone were 30¢ per unit! Result: a better-looking, more efficient unit which sells at a 10% lower price!

GREATER POWER AT NO EXTRA COST helped a Chicago office machine manufacturer* boost the saleability of his product. Lower handling, shipping, and assembly costs, modern appearance, and the sales value of the G-E monogram cause this well-known manufacturer to credit the G-E motor with making it "easier to design, build, ship, and sell" his machines.

UNSURPASSED DEPENDABILITY of the "years-ahead" G-E motor is a proven fact to thousands of manufacturers. A typical experience is that of a California compressor manufacturer*, who introduced a G-E powered paint sprayer over two years ago. To date 99.9% of these units have never required motor service.

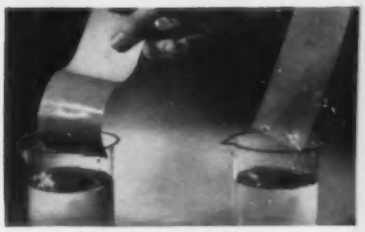
TREMENDOUS SALES APPEAL of products designed to take advantage of all the G-E motor benefits is typified by the case of a West Coast pump manufacturer*. Just one year after introducing a streamlined new unit, made smaller and easier to handle by the G-E motor, his manufacturing costs had been reduced and his ***sales had doubled!***

"Years-ahead" design and proved performance of the G-E motor are helping to establish the leaders in many fields. If you'd like more information, or help in taking greater advantage of the G-E motor's benefits in your products, contact your nearby G-E Apparatus Sales Office, or write to Section 702-24, General Electric Co., Schenectady 5, New York.

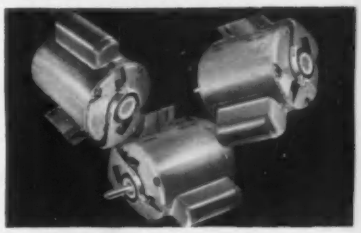
**Actual case histories available on request.*
†Dupont trade-mark for polyester film

ONLY G.E. OFFERS ALL THESE FEATURES

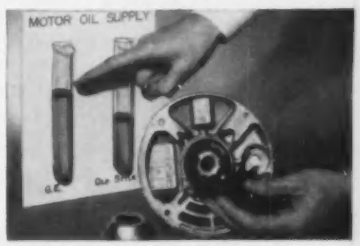
MORE COMPACT—up to 40% smaller, 50% lighter—saves you material and handling costs.



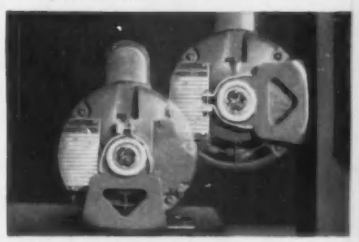
MYLAR† INSULATION (right)—35 times the moisture resistance of paper insulation (left).



ALL-ANGLE OPERATION—protective lubrication in any position—without costly specials.



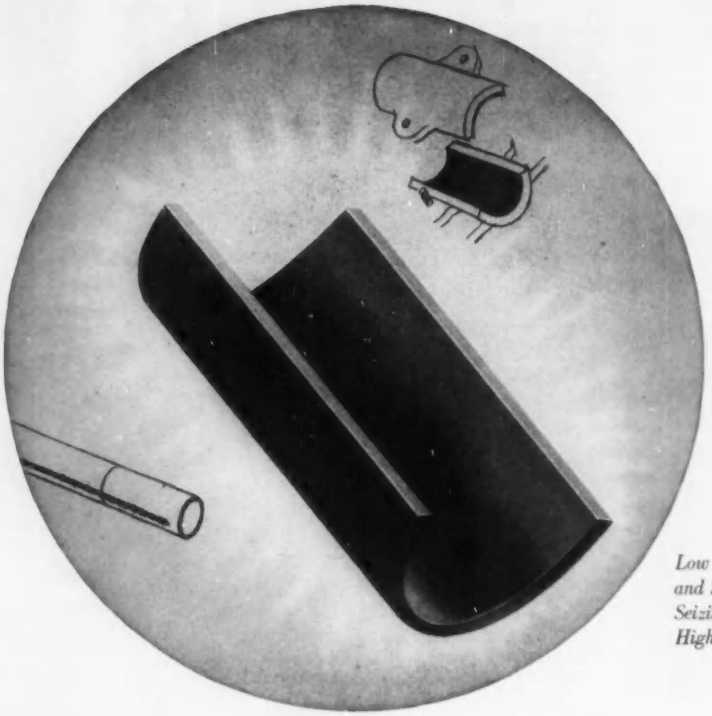
DOUBLE LUBRICATION LIFE—50% more oil, efficient retention system cut maintenance.



MOUNTING VERSATILITY—rotate motor in resilient *or solid base.* Cradle easily removed.

Progress Is Our Most Important Product

GENERAL ELECTRIC



Low Friction Bushings and Sleeves Resist Seizing, Abrasion, High Temperatures

HAYNES STELLITE Bushings and Sleeves

Trade-Mark

...for handling Hot-Abrasive Materials

Bearing parts made of HAYNES STELLITE alloy resist seizing and galling. They are hard and abrasion resistant, and will withstand the pitting effects of many corrosives. They take a high polish and are easy to apply. Use them to reclaim worn shafts or bearing blocks, and to lengthen the life of new equipment.

Operate with Little or No Lubrication

Sleeves made of HAYNES STELLITE alloy can be used in areas where efficient lubrication is impossible. They resist seizing even when lubricants are diluted by gasoline, cleaning fluids, and other liquids that wash out an oil film. They operate at peak efficiency even when lubricants decompose under heat, or are destroyed by abrasive particles.

Tough and Abrasion-Resistant

Bearing parts made of HAYNES STELLITE alloy resist the abrasive effects of wet or dry materials such as fly ash, coke, metal powder, shale, and cement dust. They are hard enough to carry heavy loads, and tough enough to stand up under repeated stress.

Heat and Corrosion Resistant

These bushings and sleeves can be submerged in many acids, alkalies, and molten metals. Temperatures as high as 1500 deg. F. have little effect on their hardness, toughness, and dimensional stability.

For more information write for our 8 page booklet on half bushings and sleeves.

"Haynes" and "Haynes Stellite" are registered trade-marks of Union Carbide and Carbon Corporation.

HAYNES TRADE-MARK ALLOYS

HAYNES STELLITE COMPANY

A Division of Union Carbide and Carbon Corporation

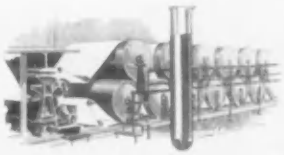
UCC

General Offices and Works, Kokomo, Indiana

Sales Offices

Chicago • Cleveland • Detroit • Houston • Los Angeles • New York • San Francisco • Tulsa

hello!



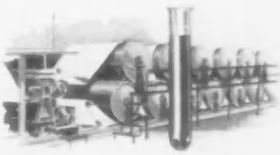
We create and make *specialty papers*, to take the place of other materials in a large and varied number of today's products, to make them *better*, for *less*.

These *specialty papers* are made from natural, synthetic, and glass fibers. They are strong, porous, pliable, absorbent, soft, practically lintless.

Perhaps *you* could use a Dexstar Specialty Paper, in place of other material, to make *your* products better, for less? There are so many applications —

Our papers, dry, are used for filters, electrolytic capacitors, vacuum cleaner bags, flat silver wrapping, lens tissues, high temperature electrical insulation.

We make "wet strength" papers for tea bags, liquid filters, cheese processing, chamois-like wipers, hair-wave kits, wallboard tape, duplicating stencils.



Yes, we can custom-make paper with most any degree of porosity, absorbency, wet, dry, lateral or longitudinal strength — or any combination of these factors.

Perhaps *you* could use a Dexstar Paper, formulated to your specifications, to make *your* products better, for less? We'd be happy to discuss it.

DEXSTAR

SPECIALTY PAPERS FOR INDUSTRY

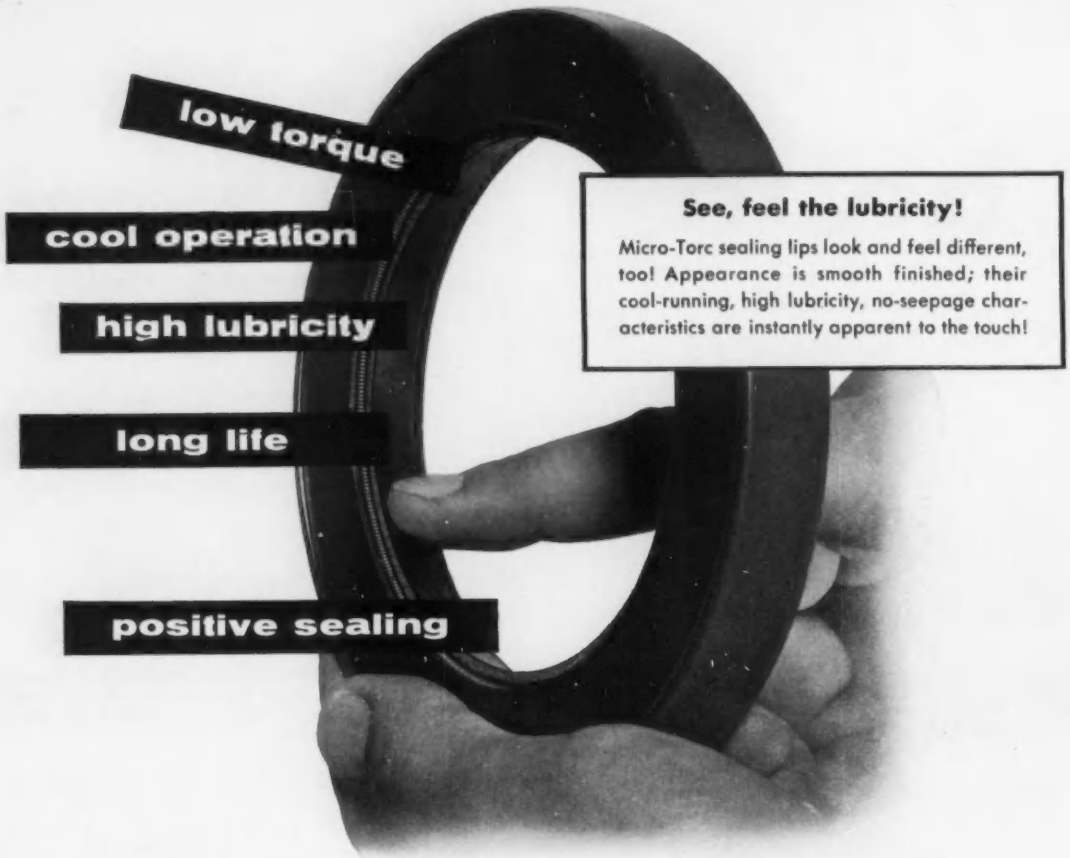
This is our trade-mark. We've been in the *specialty paper* business over a hundred years, serving hundreds of people. And we're as near as your phone.

Why not let us study *your* situation? A simple inquiry can put our complete research and development laboratories, our modern machinery — *at your service!*

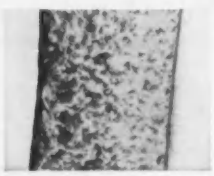
C. H. DEXTER & SONS, INC.

WINDSOR LOCKS 21, CONNECTICUT

At the Packaging Show, Booth No. 1440


low torque
cool operation
high lubricity
long life
positive sealing
See, feel the lubricity!
Micro-Torc sealing lips look and feel different, too! Appearance is smooth finished; their cool-running, high lubricity, no-seepage characteristics are instantly apparent to the touch!

NATIONAL MICRO-TORC* LEATHER OIL SEALS



How Micro-Torc works—Side of chrome retanned leather lip is coated with dry lubricant and elastomer. Elastomer binds lubricant to leather, prevents seepage through leather, enhances mechanical stability—yet permits leather's natural porosity to remain in body of sealing lip. Lip actually stores oil for dry or emergency running!

For applications where temperatures are within —50° to 200° F, maximum shaft speed is 2,000 fpm, and runout is held to about 0.005", new National Micro-Torc oil seals should definitely be investigated.

The Micro-Torc sealing member is perhaps the most interesting advance in leather oil seals in 15 years. In hundreds of thousands of hours of actual application, Micro-Torc seals have consistently shown up to 80% less torque and 10 times the life of other leather seals. Breakaway torque is normally only 20% of conventional leather seals, and Micro-Torc seals have operated up to 100 hours dry at 1,350 rpm without sloughing or squealing. Properly used, Micro-Torc seals provide positive sealing throughout service life.

Get complete details. Call nearest NMB Engineer, or write for Bulletin.
Engineering help in your plant and ours. NMB'S Application Engineering Service is fast, expert, convenient. Yours for the asking:

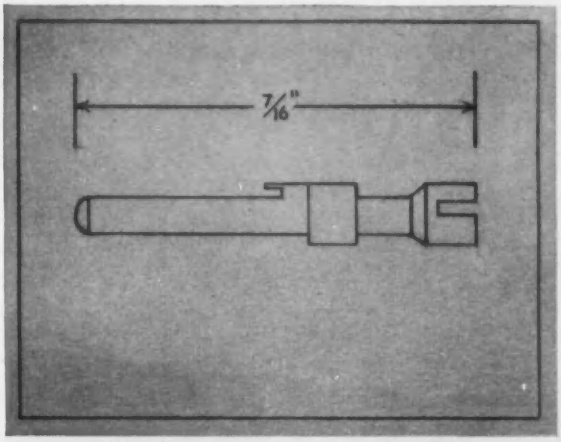
CHICAGO, ILL.	*Room 462 McCormick Building, HArrison 7-5163*
CLEVELAND, OHIO	*210 Heights Rockefeller Bldg., YEllowstone 2-2720*
DALLAS, TEXAS	*2520 West Mockinghird Lane, DIxon 7541*
DETROIT, MICH.	*13836 Puritan Avenue, VErmont 6-1909*
DOWNEY (Los Angeles Co.), CALIF.	*11634 Patton Rd., TOpaz 2-8163*
INDIANAPOLIS, INDIANA	*2802 North Delaware Street, WAlnut 3-1535*
KANSAS CITY, MO.	*4445 Terrace, LOgan 6622*
MILWAUKEE, WIS.	*647 West Virginia Street, BRoadway 1-3234*
NEWARK, N. J.	*1180 Raymond Blvd., MItchell 2-7586*
REDWOOD CITY, CALIF.	*Broadway and National, EMerson 6-3861*
WICHITA, KANSAS	*519 South Broadway, AMherst 2-6971*

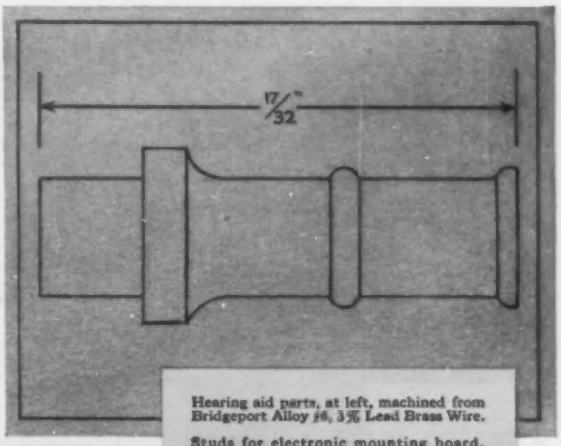
*T. M. REG.

NATIONAL
OIL & GREASE SEALS
O-RINGS SHIMS
Product of the world's largest exclusive manufacturer of oil seals

NATIONAL MOTOR BEARING CO., INC.
Plants at Van Wert, Ohio, Redwood City, Downey and Long Beach, Calif.
General Offices: Redwood City

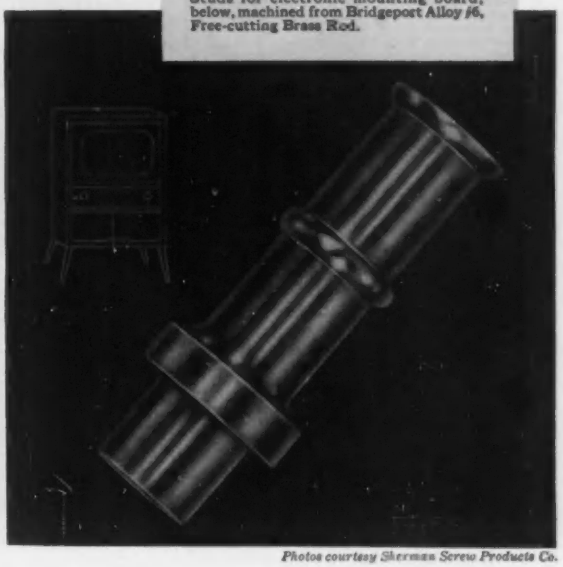
Matching metal to job with Bridgeport alloys





Hearing aid parts, at left, machined from Bridgeport Alloy #6, 3% Lead Brass Wire.

Studs for electronic mounting board, below, machined from Bridgeport Alloy #6, Free-cutting Brass Rod.



Photos courtesy Sherman Screw Products Co.

Faster, easier, more accurate machining with Bridgeport HIGH I. Q.* Rod

Matching metal to job with Bridgeport Alloys can cut your production costs . . . increase your profits. To get the job done right, tell Bridgeport your production and service requirements—Our Technical Service will gladly help you select, from a complete range of High I. Q. alloys, the particular one that will serve you best. Call your Bridgeport sales office today.

**High Inner Quality*

BRASS Bridgeport CO.

BRIDGEPORT BRASS

Offices in Principal Cities • Conveniently Located Warehouses

Bridgeport Brass Company, Bridgeport 2, Connecticut • In Canada: Noranda Copper and Brass Limited, Montreal

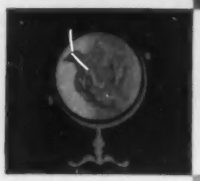
DOW

LOOKING FOR NEW AND PROFITABLE DESIGN APPLICATIONS?

Dow has the answer—

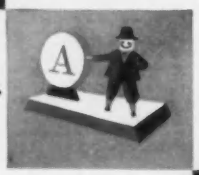
STYRON 475 PLASTIC SHEET

Inner door liners are just one example of many complicated appliance and refrigerator parts made with easily formed Styron 475 sheet!



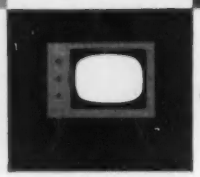
There's no limit to colorful, high-impact Styron sheet's applications in the novelty fields!

Many beautiful three-dimensional displays and signs are formed of low-cost Styron 475 sheet!



The list of its advantages below shows why more and more packaging men have turned to dependable Styron 475 sheet!

Versatile Styron 475 sheet sets the pace for realistic detail, extra play value and longer play life in today's fastest-selling toys!



Styron 475 sheet is the choice of many radio and TV manufacturers for masks, back and tube enclosures and insulating shields!

YOUR PRODUCT GOES HERE

You can use these Styron® 475 sheet advantages to cut your operating costs—

1. Economical
2. Will not corrode, rust or tarnish
3. Easily formed and fabricated (punched, die-cut, stamped, vacuum-formed)
4. Adaptable to most painting and printing methods
5. Excellent resistance to water and moistures
6. Will not support mildew, mold and fungi
7. Lightweight
8. Chemically compatible with a majority of packaging materials
9. Reusable or disposable
10. Wide range of opaque and semitranslucent colors
11. Nontoxic
12. Has good chemical resistance

Extra advantages—*extra* profits! Those are the keys to the increasing favor Styron 475 sheet is finding with design engineers everywhere. Styron 475 sheet is a high-impact polystyrene formulation produced as a sheet in a variety of sizes, thicknesses and colors. Styron 475 sheet is also available from leading manufacturers in your area. Experienced fabricators in your area can do outstanding work to your specifications. Write Dow today—we'll put our years of plastic sheet know-how to work for *you*. You can count on prompt, personal attention to your specific needs. THE DOW CHEMICAL COMPANY, Midland, Michigan.

Plastics Sales Department, PL-491J
The Dow Chemical Company, Midland, Michigan

Please rush technical data on Styron 475 sheet and nearest source of supply.

Name and title_____

Firm name_____

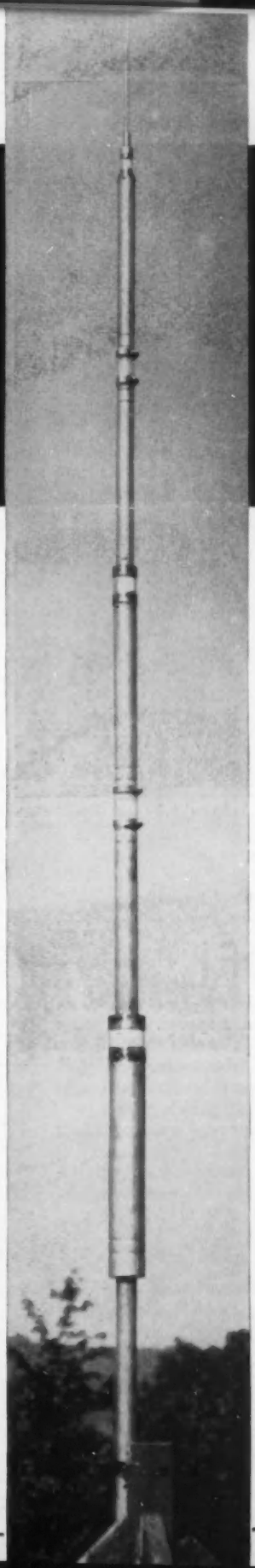
Types of product manufactured_____

Address_____

City_____ Zone____ State_____

you can depend on DOW PLASTICS

DOW



Mast of
SHELBY SEAMLESS TUBING
(USS STAINLESS STEEL)
provides high strength and corrosion resistance for coaxial antenna

The Type 3006 Coaxial Colinear Antenna*, consisting of three half-wave vertical dipoles arranged colinearly and operating on a frequency range of 152-176 MC, is especially suitable for patrol car broadcasting. The three vertically arranged dipoles exhibit a gain of 5 to 6 db over a standard single dipole, and produce a low angle of radiation with equal radiation in all directions.

This 13½-foot, 40-pound antenna is supported by a mast made of Shelby Seamless Tubing (USS Stainless Steel) running through its center. In addition to possessing the tensile strength to withstand 100-mile-per-hour winds, this stainless supporting mast has high corrosion resistance—will not flake from oxidation and cause short circuits.

In such critical applications where superior strength, uniformity, dimensional accuracy and corrosion resistance are needed, Shelby Seamless Tubing of USS Stainless Steel is consistently chosen to meet the requirements. Shelby Seamless Tubing, available in a wide range of diameters, wall thicknesses, various shapes and steel analyses, is produced to exacting standards by the world's largest manufacturer of tubular steel products. If you wish, our engineers will make a study of your requirements, and will help you apply Shelby Seamless Steel Tubing to your specifications.

*Name of manufacturer on request.

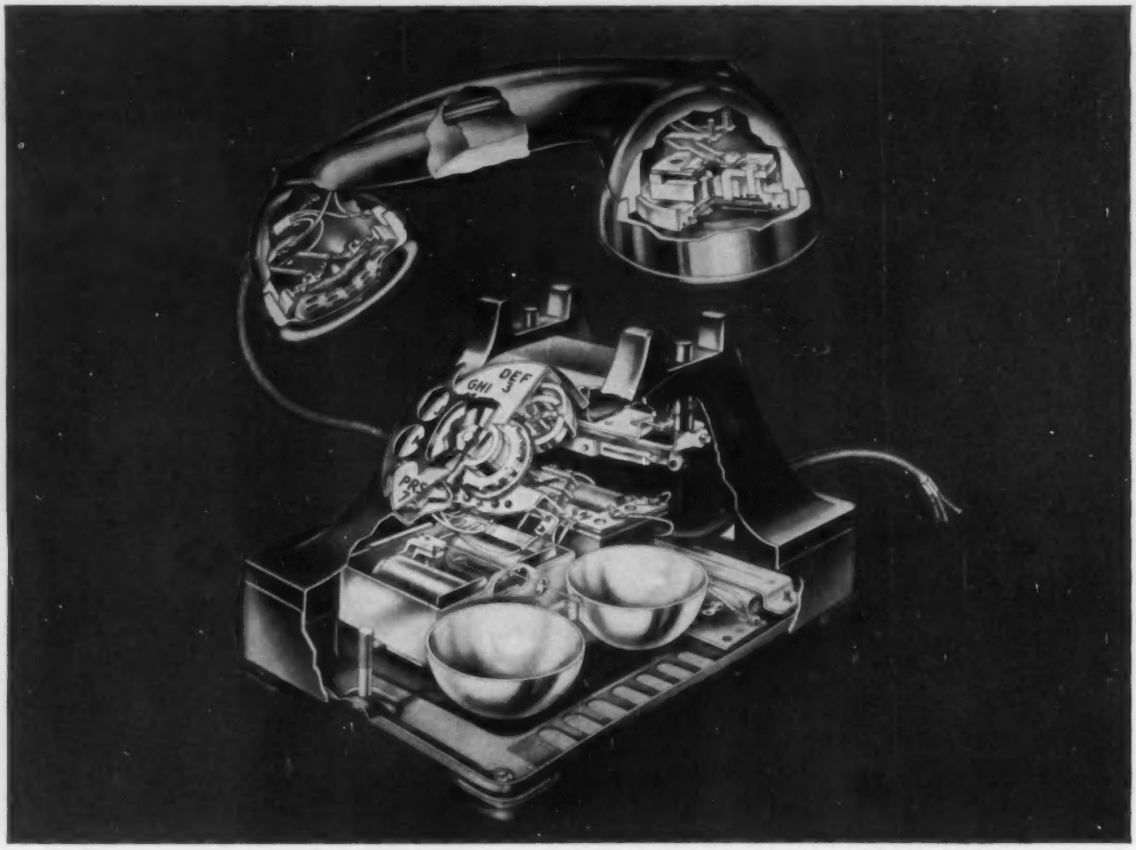
WELLS WITHOUT WELDS

NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)

COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS · UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS **SHELBY SEAMLESS MECHANICAL TUBING**

UNITED STATES STEEL



In critical places your telephone uses COPPER . . . for space-saving, for high electrical conductivity and ease of joining, for dependable performance.

COPPER
speaks for itself!

Everyone who uses copper learns something from it . . . something no substitute can teach.

To the man who machines or stamps or draws metals, copper and its alloys speak of easy workability.

To the firm that uses copper parts instead of substitutes, copper tells the story of satisfaction . . . of standing up in service.

To the designer of complicated equipment, copper offers savings in valuable space . . . permits "miniaturization".

And to the home-owner wise enough to install copper throughout his "castle", time itself tells an unending tale of trouble-free enjoyment.

Copper will speak for your product, too. It will signify *quality!*

It costs you less to make your product well, before it is sold . . . than to make it good, afterwards.

COPPER & BRASS
RESEARCH ASSOCIATION
420 Lexington Avenue, New York 17, N. Y.

. . . AN INDUSTRY SOURCE OF TECHNOLOGICAL AID, INCLUDING A LIBRARY OF TECHNICAL LITERATURE AND A COUNCIL OF SPECIALISTS

COPPER OR ITS ALLOYS PROVIDE THESE ADVANTAGES:

Best conductor of electricity commercially available

Does not rust . . . high corrosion resistance

Best heat transfer agent of all commercial metals

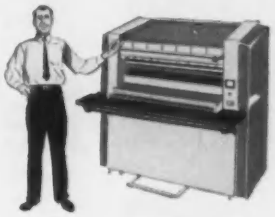
Easy to machine, form, draw, stamp, polish, plate, etc.

Welds readily . . . excellent for soldering and brazing

You Need It!

The boom in production means more pressure than ever for engineering prints. A new, modern reproduction unit with higher speeds, more operator conveniences will help you deliver them.

You Want It!



Take this opportunity to replace that old, inadequate reproduction machine with the efficient new unit you've been wanting—a faster, better engineered, and trouble-free *modern* machine!

You'll Surely Get Management Approval!

If your firm, like most, is gearing up for greater-than-ever production, you couldn't pick a better time to get the approval of management for new, modern, higher-production equipment.

NOW Is the Time to Get Your New, Modern Bruning Copyflex Machine!

To meet production's push for more engineering prints, you couldn't pick a better time to get a new, modern reproduction machine. And you couldn't make a wiser choice than efficient, trouble-free Copyflex!

In just the last year, Bruning has introduced five new, advanced machine models, one of which is shown at the right. These machines offer you the famous problem-free installation and operation of Copyflex . . . no exhaust venting, no plumbing or auxiliary equipment, no installation other than an electrical connection. They bring you faster reproduction speed and a host of operator conveniences such as fast return of originals, automatic separation, front or rear delivery. They are efficient, economical, modern reproduction machines that will help you boost your drafting room output, keep costs at a minimum.

Now is the time to act. Mail the coupon below. You'll be glad you did!

COPYFLEX MODEL 500—A new, ultra-fast, heavy volume machine offering top mechanical speed of 40 f.p.m., automatic separation, front or rear delivery, automatic stacking, and a host of other advanced features.

BRUNING *Copyflex*

Best Process! Best Machines! Best Selection of Materials!

Specialists in Copying Since 1897

CHARLES BRUNING COMPANY, INC. • 4700 Montrose Ave., Chicago 41, Illinois

In Canada: Charles Bruning Company (Canada) Ltd., 105 Church St., Toronto 1, Ont.

Charles Bruning Company, Inc., Dept. 43-O
4700 Montrose Ave., Chicago 41, Illinois

Please send me information on Copyflex process and Model 500 Machine.

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ COUNTY _____ STATE _____

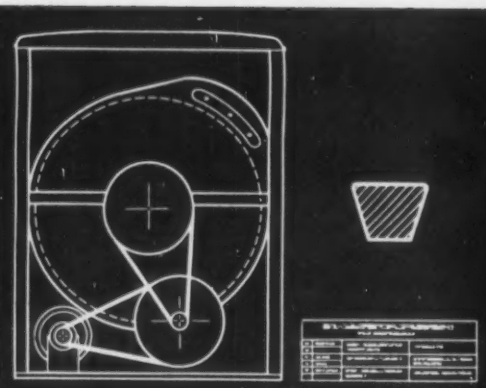
How Dayton V-Belts enabled appliance makers to design more efficient, compact Washers and Dryers of higher styling!

Case History Spec. No. K12078

The Problem: Obtain peak drive performance for new automatic dryer designed with a highly restricted speed range heretofore impractical. Reduce inherent drive noise.

The Approach: Develop special V-Belts and build test machines which will duplicate exact dryer conditions.

The Solution: New V-Belt 100% effective in maintaining desired speed within required limits, elimination of drive noise.



Dayton V-Belt turns dryer drum, silently, at exact speed required to produce dry, fluffy clothes.

Case History Spec. No. K12078 relates the successful efforts of one major appliance manufacturer to maintain and hold dryer speed within its most efficient range.

The Problem:

1. To develop a dryer V-Drive capable of maintaining drum speed within rigid range limitations.

2. In addition, to neutralize inherent noise caused by a floating idler type assembly confined in a metal cabinet.

Approach to Solution:

1. After consultation with appliance designer engineers and review of specifications, Dayton V-Belt engineers made recommendations regarding tolerances for pulley groovings and motor speeds.

2. Test machines were then developed, at Dayton Rubber, so calibrated that infinite speed differentials could be measured in checking sample V-Belts at precise speeds.

3. V-Belt samples were then produced to reach and maintain close speed tolerances.

4. Alterations in cross-section and construction followed to build samples capable of operating within specific speed requirements, pulley diameters, tolerances, tensions, etc.

5. New samples met all speed restrictions perfectly—only one problem remained: Elimination of noise.

6. Further refinement in V-Belt design and construction produced a noiseless V-Belt drive.

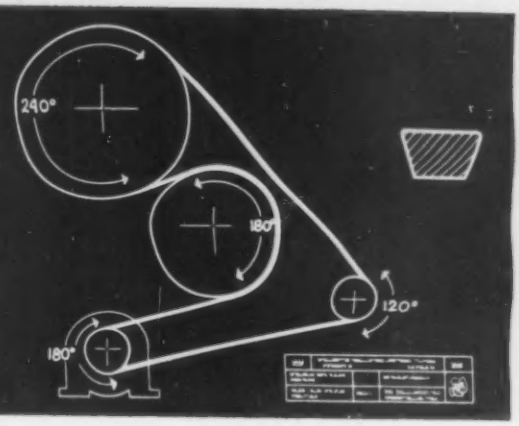
7. Result: The new automatic dryer operated *continuously* and silently, at the exact speed desired for most effective performance, thanks to Dayton V-Belts and Dayton V-Belt engineering assistance.

Case History Spec. No. L14133

The Problem: Tortuous back bend, limited take-up area plus small pulleys combine to create unusually rugged conditions for V-Belt drive on washer.

The Approach: Build new, highly flexible V-Belt with low-stretch qualities and high co-efficient of friction.

The Solution: New belt maintains tension, eliminates vibration and "stays put" within adjustable limits.



Spec. No. L14133 highlights advantages of Dayton engineering on multiple-feature drives.

The Problem:

Washer drive specifications called for V-Belt to operate over small pulleys subjected to a tortuous back-bend in driving spinning drum.

The Approach to Solution:

In designing a V-Belt with the necessary flexibility and tension to operate on the small pulleys and take the terrific back bend it was also necessary to provide a smooth back surface on the belt to insure against vibration.

The Solution:

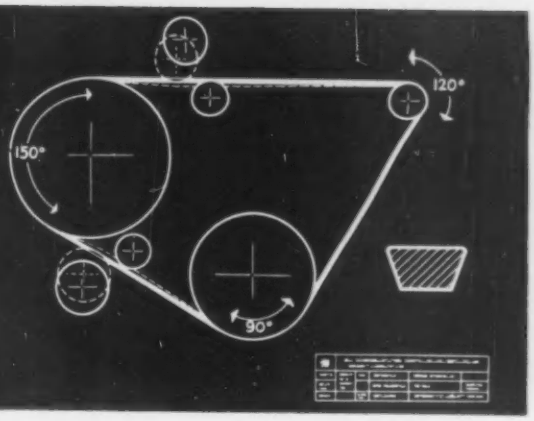
Special cords and new internal belt construction provide the answer. Smooth contact with spinning drum was solved by a special V-Belt manufacturing process exclusive with Dayton Rubber.

Case History Spec. No. D13912

The Problem: To obtain maximum power transmission for washer employing V-Belt in restricted space over sub-diameter pulleys.

The Approach: Explore possibilities for developing a V-Belt with unusually low stretch factor.

The Solution: New V-Belt produced for present production. Follow-up research and development instituted for later improved models.



Spec. No. D13912 emphasizes value of engineering assistance of automatic washer drive.

The Problem:

Space limitations required V-Belt transmit full power over extremely small sub-diameter pulleys without slippage.

Approach to Solution:

1. Experimental V-Belts were built with a high degree of flexibility to provide greater grip on sub-diameter pulleys and in addition, made assembly easier.

2. Special low-stretch cord was processed and incorporated to maintain tension throughout V-Belt life.

3. Laboratory and field tests proved dependability of new V-Belt and assured long service life.

The Solution:

A V-Belt was produced rugged enough to meet *every* requirement of the new automatic washer.

Further Development:

The solution was only the beginning for Dayton. Continued research and testing were begun at once to meet other new operational requirements for later models.

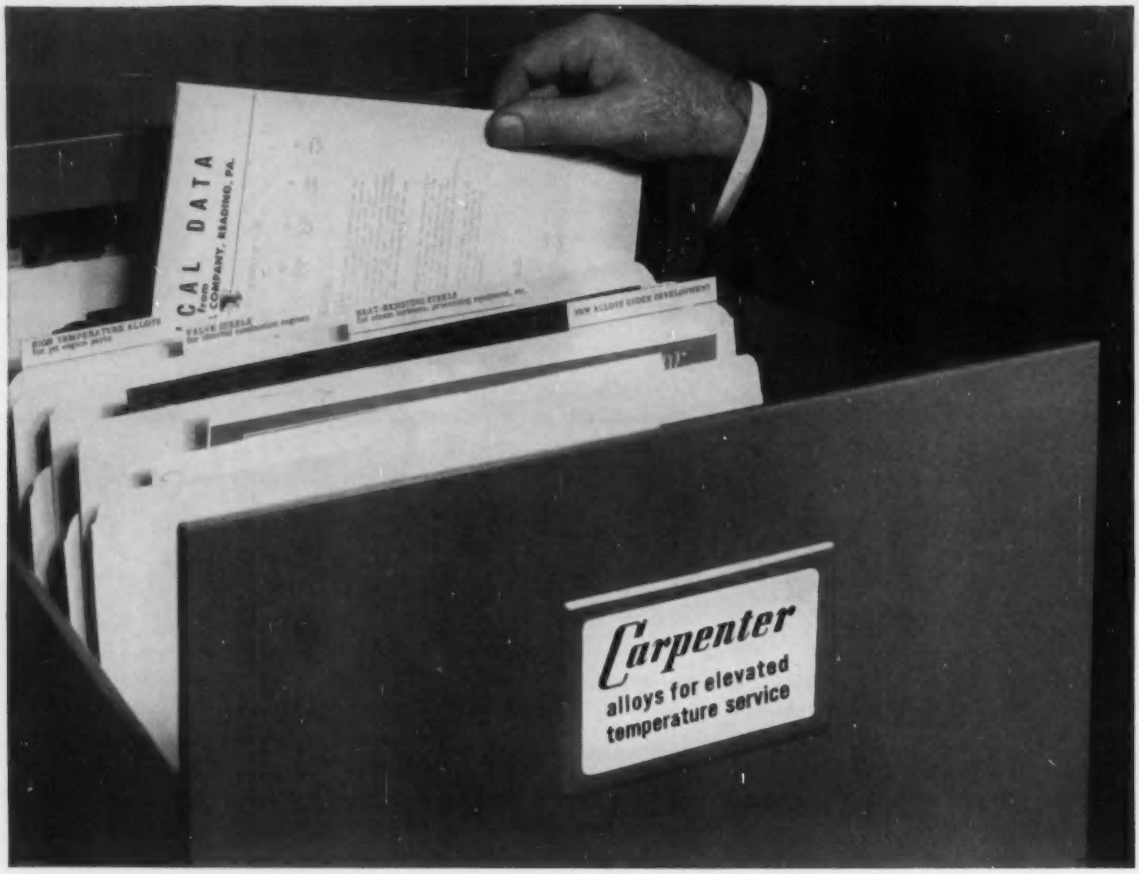
These Case Histories typify the close engineering assistance available from Dayton's experienced staff of V-Belt engineers. For assistance in improving your appliance write: Dayton Rubber Co., Industrial O.E.M. Div., Dayton 1, Ohio.

© D.R. 1956

Dayton Rubber

51 YEARS OF PROGRESS

WORLD'S LARGEST MANUFACTURER OF V-BELTS



Discover how these ELEVATED TEMPERATURE ALLOYS can give you

√ Improved Forgeability √ Greater Uniformity √ Cleaner Steels

Exciting possibilities for improvement are ahead when you look into the line of Carpenter alloys for parts or products in elevated temperature service. Here is a line of high temperature and heat-resisting alloys produced in a specialty mill. Only a true specialty mill can produce so well these very difficult-to-make alloys.

Here, too, is a combination of unusual advantages not normally found in this type of alloys. For example, Carpenter pioneered the addition of rare earth elements to the analyses of certain grades to give you improved forgeability. And Carpenter's unsurpassed, meticulous quality controls, assure you steels with greater uniformity and extra cleanness to meet the strictest inspection requirements.

Whether you work with one of our present elevated temperature alloys, or a steel produced specifically for your own application, you'll find that Carpenter's wealth of fabricating and working information will help you substantially reduce production costs and get better parts.

Outline your plans or problems to your Carpenter Representative or write direct. You'll get the kind of help that pays off with definite improvements. *The Carpenter Steel Co., 117 W. Bern St., Reading, Pa.*

Specify Carpenter alloys for elevated temperature service and get these three big advantages . . .

Improved Forgeability
Greater Uniformity
Cleaner Steel

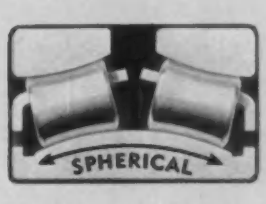
Carpenter STEEL

Improved Alloys for Elevated Temperature Service

MORE FACTS on why more and more leading manufacturers choose Link-Belt bearings

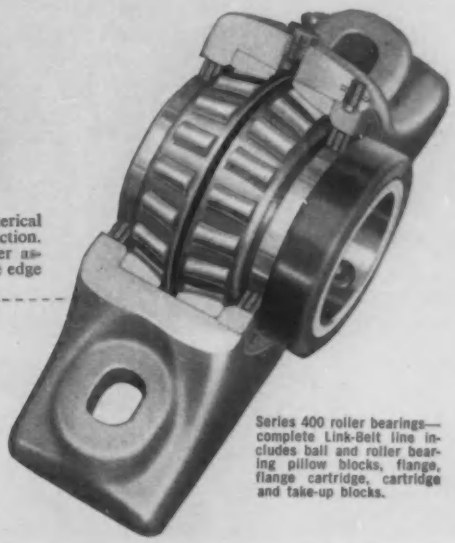
EASY, LOW-COST INSTALLATION—Series 400 bearing blocks are quickly mounted on commercial shafting from ¾ to 4-in. diameters.

HEAVY COLLAR SECURELY LOCKS INNER RING TO SHAFT. Use of setscrews in collar avoids distortion of inner ring. Tension of collar against heavy setscrews assures tightness.



FREE ROLLING—SELF-ALIGNING. Spherical inner ring is free to align in any direction. Load is distributed over entire roller assuring full load capacity. Destructive edge loading cannot occur.

CONTACT-TYPE SEAL, left, of felt laminated with synthetic rubber for extremely dirty conditions. **LABYRINTH SEAL,** right, for normal conditions. Bearings are pre-lubricated and sealed at factory.



Series 400 roller bearings—complete Link-Belt line includes ball and roller bearing pillow blocks, flange, flange cartridge, cartridge and take-up blocks.

Fast, easy mounting

—a key feature of these self-aligning, high-capacity roller bearings

● Hundreds of equipment manufacturers who use roller bearings choose the popular, high-capacity Link-Belt Series 400. Compactness promotes neatness of machinery design . . . easy mounting reduces installation costs. And field service has developed an unmatched performance reputation because of many valuable features.

Series 400 pillow blocks are equipped with self-aligning, double-row roller bearings. Even under shaft deflection and misalignment, bearing maintains full load capacity during its long life.

This quality bearing is part of industry's most complete line of ball and roller bearing blocks—made at a Link-Belt plant devoted exclusively to these precision products. For Book 2550 on the full line—ask one of the 40 Link-Belt offices nearest you.

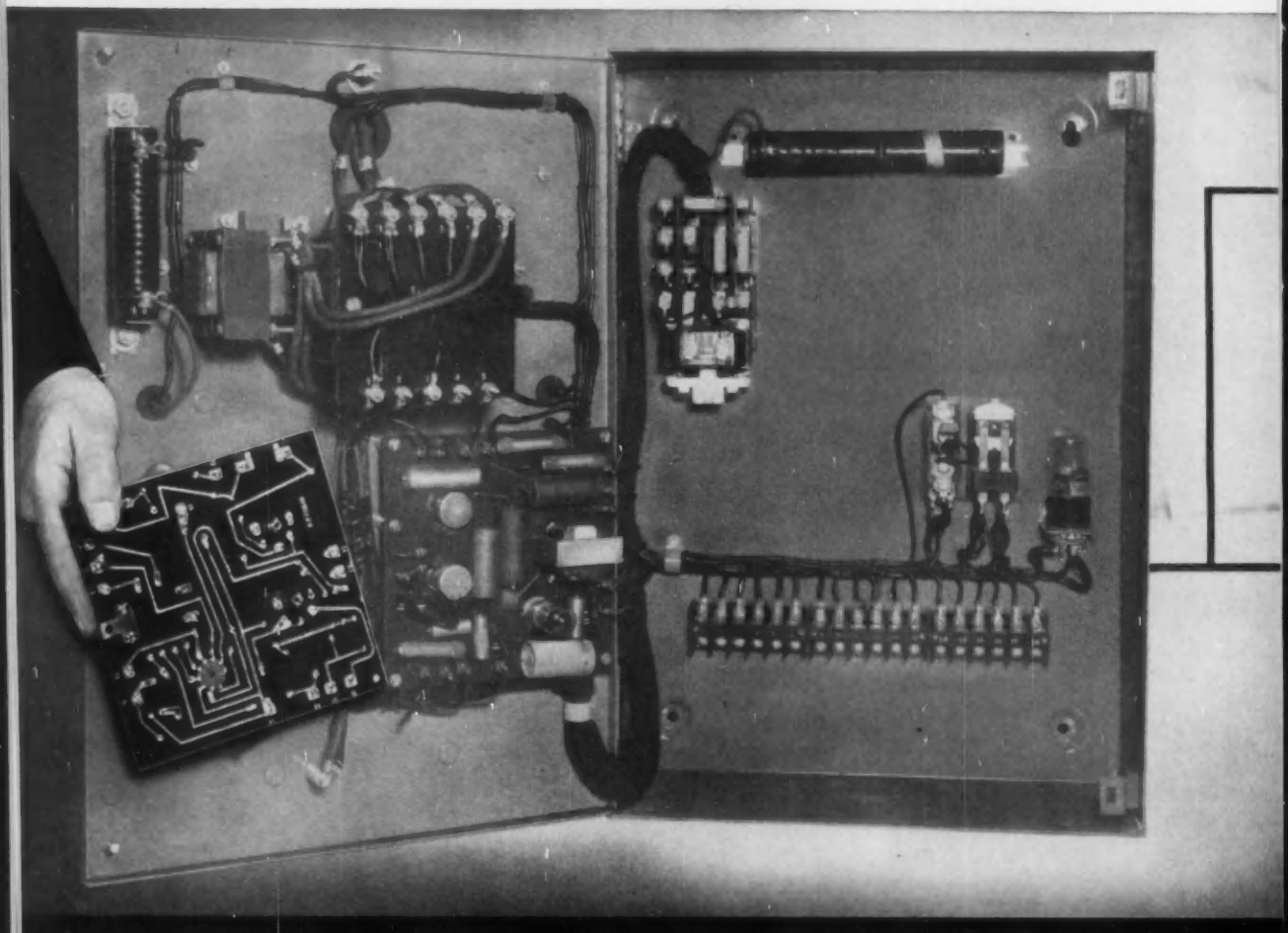
LINK-BELT

Ball and Roller Bearings

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13.260-A

GENERAL ELECTRIC ANNOUNCES ADDITION TO THY-MO-TROL*

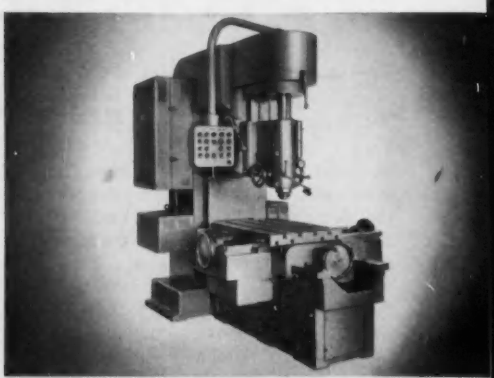
NEW Low-priced 3/4-3 HP



G-E THY-MO-TROL DRIVES ARE IDEALLY SUITED

Electronic Induction Heater. Thy-mo-trol Drive moves the carriage to exact pre-set conditions to assure uniform heat treatment.

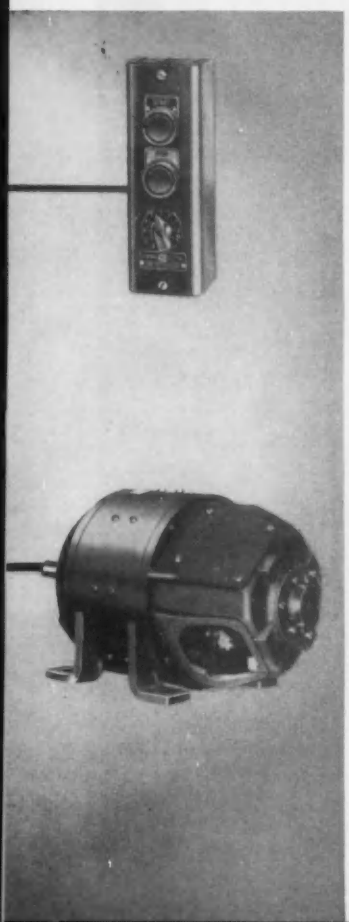
Surface Grinder. All motions on this grinding machine are controlled by General Electric's Thy-mo-trol Drive: spindle, table and cross-feed operations.



Milling Machine. Thy-mo-trol Drives automatically step up production on this milling machine by giving correct speeds for spindle, table and spindle head drive requirements.

DRIVE LINE . . .

Thy-Mo-Trol Drive with Printed Circuitry



NOW! FOR MACHINE TOOL APPLICATIONS —A RELIABLE, SIMPLIFIED, ADJUSTABLE SPEED DRIVE

These new, simplified General Purpose, 3/4-3 HP Thy-mo-trol Drives have been developed for industrial applications demanding wide speed range and close speed regulation. Embodying all the smooth adjustable speed characteristics of DC drives, the two models offer greater performance, reliable operation and wide speed range selection for many industrial applications.

A PRICE REDUCTION, due largely to G.E.'s industrial application of printed circuitry has been made. The entire control system has been simplified, giving the user substantial reductions in over-all weight, size, circuit complexity, amount of wiring, maintenance costs and installation costs.

OPERATING DIRECTLY FROM AC POWER, the new Thy-mo-trol Drives can increase machine production on most applications because they • Give the correct speed for the required operation • Reduce operating spoilage and rejects because of high accuracy performance and • Increase machine versatility because of the wide speed range and close speed regulation features offered.

THE COMPLETE THY-MO-TROL DRIVE LINE COVERS ratings from 1/40 to 30 HP and beyond. Speed ranges of 5:1, 20:1, 50:1, and 100:1 are typical. Speed regulation of ½ of 1% is possible over the entire speed range.

SIMPLIFIED FRACTIONAL HORSEPOWER THY-MO-TROL DRIVES are supplied as half-wave or full-wave units, allowing a wide selection of performance standards to meet each particular industrial application.

HIGH PERFORMANCE INTEGRAL HP THY-MO-TROL DRIVES, 3/4-30 HP, full-wave offer these superior performance features: greater flexibility, rugged industrial-type construction, easy maintenance, wide speed range, adjustable current limit, flat speed regulation and optional features such as: jogging, quick slowdown, reversing, dynamic braking, tachometer feedback and position synchronization all add up to qualify these drives for many machine tool and industrial applications.

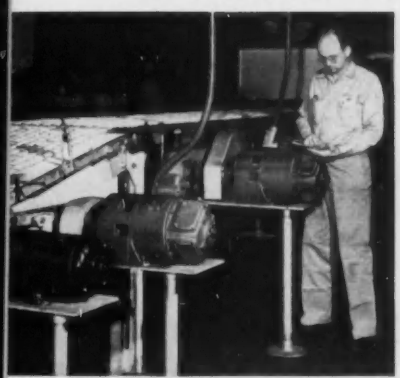
FOR MORE INFORMATION on General Electric's Thy-mo-trol electronic adjustable speed drives, contact your nearest G-E Apparatus Sales Office or write for Bulletins GEA-6234, GEA-4089, GEA-5179, GEA-5827 and GEA-5337—General Electric Company, Schenectady, N. Y. 791-2

Progress Is Our Most Important Product

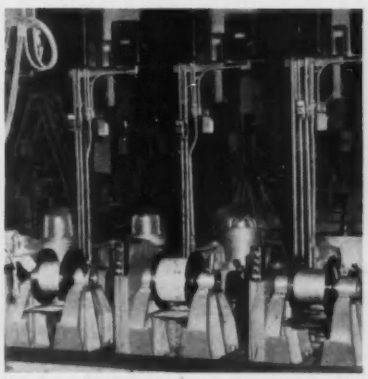
GENERAL ELECTRIC

® Reg. Trade-mark of General Electric Company.

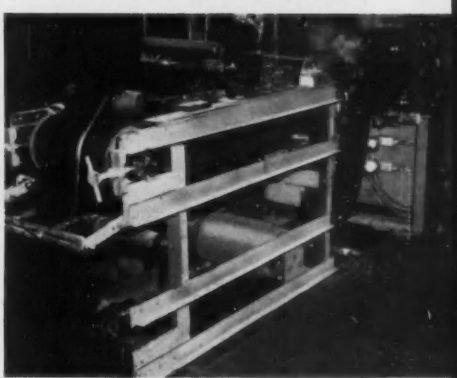
TO THESE TYPICAL INDUSTRIAL APPLICATIONS



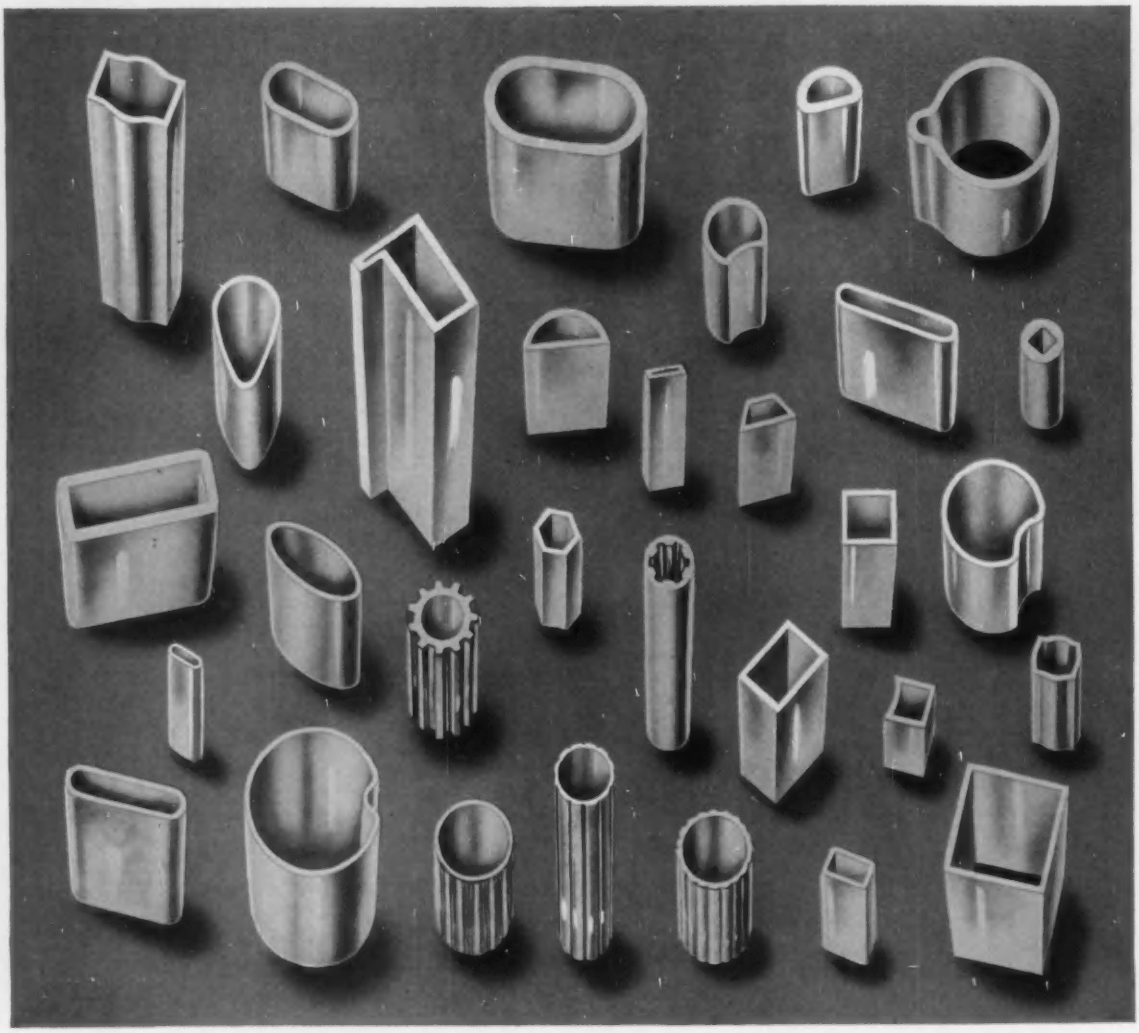
Cookie Conveyor. Repeated variations in speed—necessary to meet baking requirements—are easily handled by Thy-mo-trol Drive.



Wire Re-Winder. As the coil of wire builds up, Thy-mo-trol Drive continually adjusts speed of reel to maintain constant winding at maximum speed.



Tire-Treading Machine. A continuous strip of tire-tread passes from extruder (in background) to conveyor. Thy-mo-trol Drive synchronizes the operation.



YOU NAME THE TUBE SHAPE AND THE METAL

Our specialized facilities and stock tools can save you time and money

Special-shape seamless tubes in straight lengths, or cut into short pieces, can save several steps in arriving at a finished product—can save you material and many direct labor costs. The American Brass Company's French Small Tube Division has turned out thousands of tubes in special shapes up to ¾" O.D. A variety of stock tools is available to save fitting-up charges.

For consumer products: Some special tubes are produced to the accepted commercial tolerances and finishes for such applications as electric fixtures, furniture ferrules, heat exchangers, radiator tubes, refrigeration controls, hardware, jewelry, automatic pencils, and a host of others.

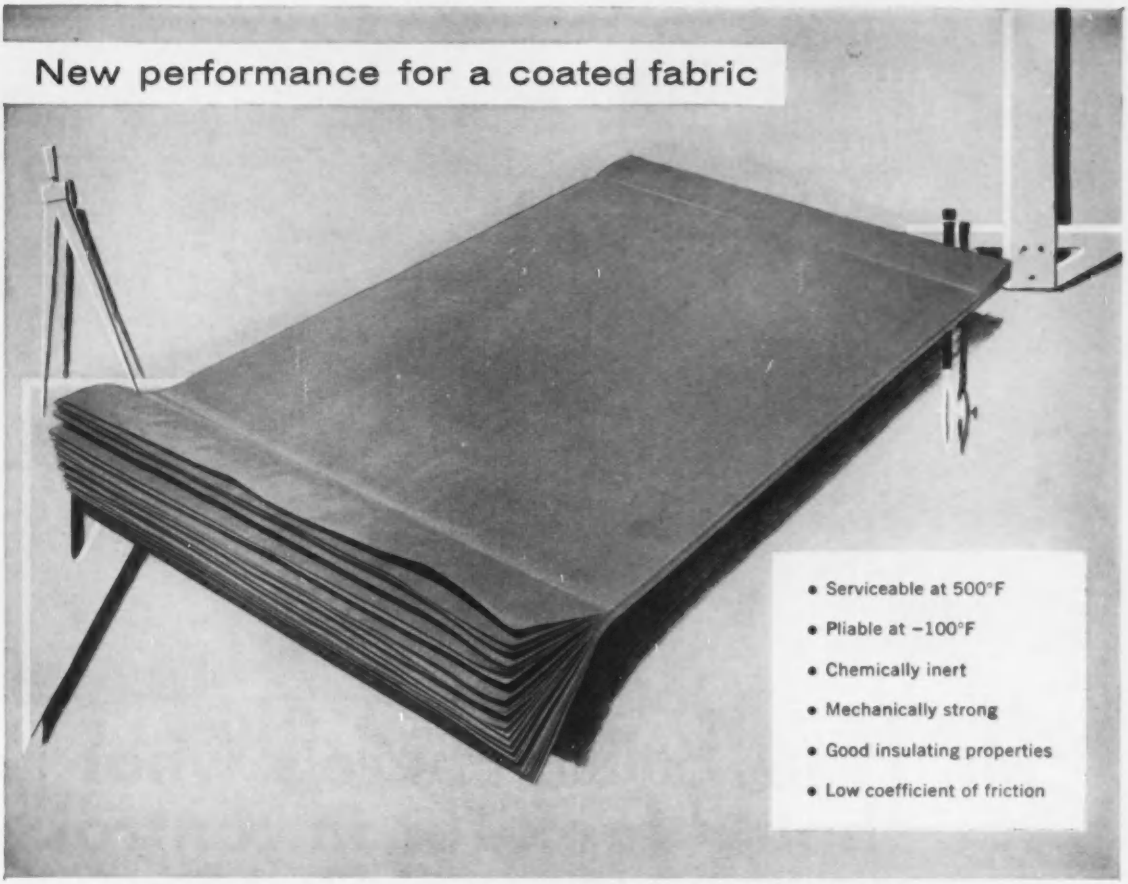
High precision products: Many are made unusually accurate in I.D. and O.D. dimensions, with specially cleaned inside and outside surfaces, for parts for control instruments and for other scientific and industrial equipment.

Wide choice of metals: Special-shape tubes are available in copper, brass, bronze, nickel silver, special copper alloys, and aluminum — furnished in straight mill lengths or accurately cut to your specifications.

For action: See your American Brass Company representative or send in a sample, drawing, or description, together with the quantity you need, the metal, and other pertinent data. Address: The American Brass Company, French Small Tube Division, Waterbury 20, Conn.

ANACONDA®
SPECIAL-SHAPE TUBES

New performance for a coated fabric



Exceptional properties of this Du Pont laminate suggest new design applications

If your product must operate under extreme thermal, chemical or mechanical conditions, you should take a close look at Du Pont's new laminate—"Armalon" tetrafluoroethylene resin coated glass fabric. It combines remarkable chemical resistance of "Teflon"* with the strength and inertness of glass fabric.

"Armalon" coated glass fabric comes in full-width material to 38", as tape or multiple-ply laminates in a wide range of thicknesses. Laminates are easily machined and formed into parts such as bushings, gaskets, valve and pump packings. "Armalon" coated glass fabric is chemically inert, tough, does not absorb water and has a remarkably low coefficient of friction. Find out how "Armalon" can help you. Mail the coupon today.

*Teflon is Du Pont's registered trademark for its tetrafluoroethylene resin

Exhaust pipe heat and an inaccessible grease fitting meant trouble in the metal clutch-lever bushing of a leading automobile. A wrap-around bushing of "Armalon" tested out OK after the equivalent of 10 years' driving.

DU PONT INDUSTRIAL COATED FABRICS

DU PONT
REG. U.S. PAT. OFF.

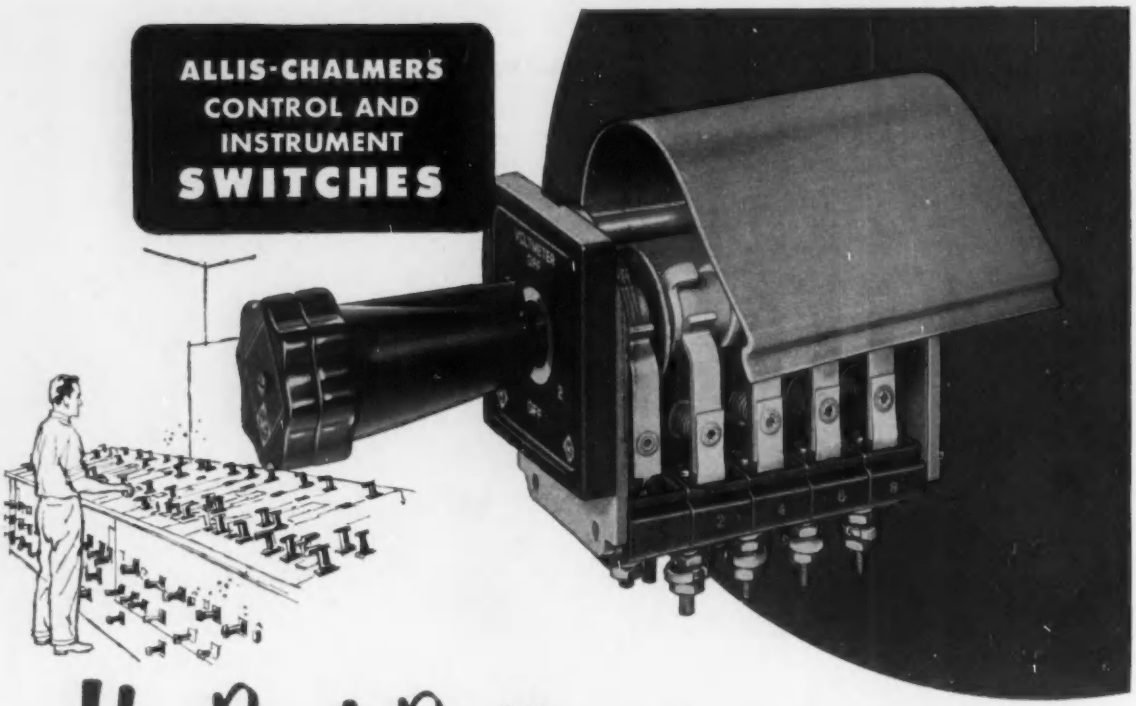
BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

E. I. du Pont de Nemours & Co. (Inc.)
Industrial Coated Fabrics Division, PE-64
Wilmington 98, Delaware

Please send me your free booklet describing properties and applications of "Armalon" coated glass fabric laminates.

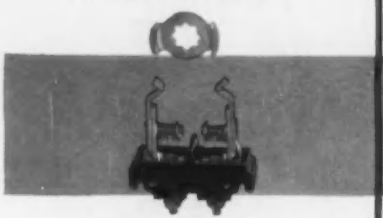
*Name*_____ *Position*_____
*Firm*_____
*Address*_____
*City*_____ *State*_____

ALLIS-CHALMERS CONTROL AND INSTRUMENT SWITCHES



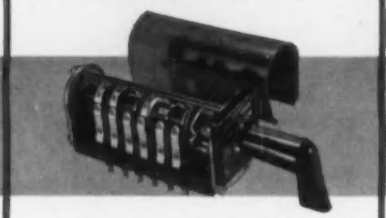
Mr. Panel Builder... here's what you should look for in control and instrument switches

FLEXIBILITY



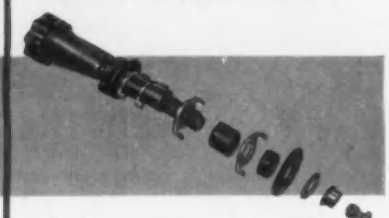
Each pair of stationary contact fingers is mounted individually. Unit construction facilitates adding stages and makes contact replacement easy.

ACCESSIBILITY



Snap-on cover can be lifted off —requires only a minimum space for removal. Arrangement of terminals permits wiring without removing switch cover.

DEPENDABILITY



Positive contact motion and definite contact position are made possible through the use of square shaft and star-holed contact segments.

Allis-Chalmers manufactures switches in a wide variety of types and contact arrangements to meet your specific requirements — with standard models available from stock. Write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin. Ask for Bulletin 14B8112.

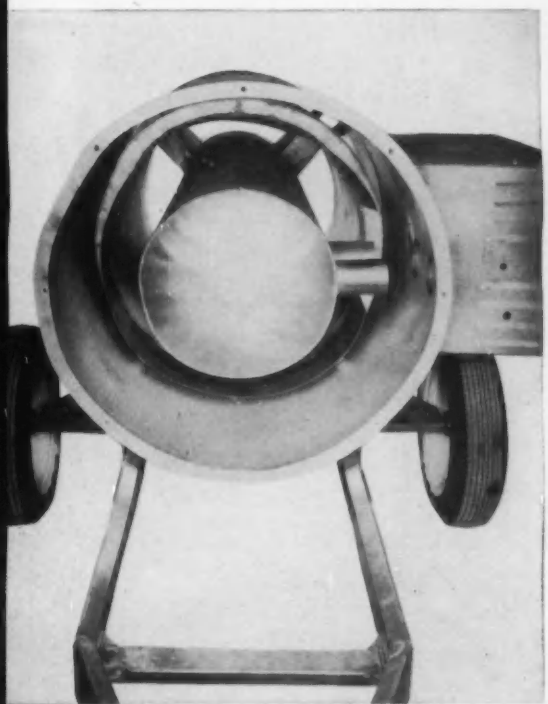
A-4952

A-C ALLIS-CHALMERS

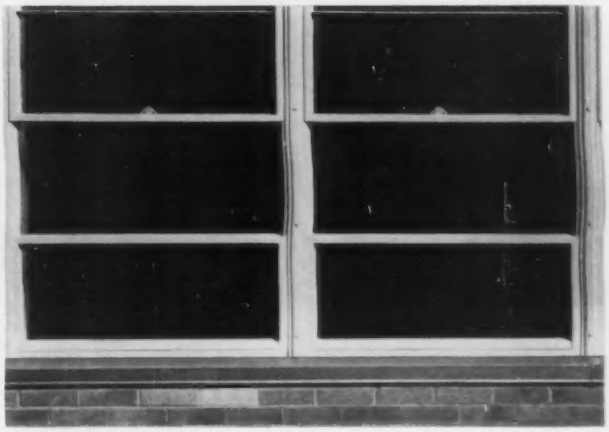
ALLIS-CHALMERS

FOR TRAILERS THAT DO NOT WEAR OUT. This Fruehauf trailer has sides made from thin sheets of Stainless Steel, corrugated into walls that are only one inch thick. That's why it can carry more cargo than trailers of other, heavier types of construction. Most joints are welded, an easy job with Stainless. There is nothing to corrode or loosen; in fact, no Stainless trailer has ever worn out!

NOTHING *can equal Stainless Steel*



FOR HEAT RESISTANCE. This is a Lennox Crop Dryer. It burns 12 gallons of fuel oil per hour and has an input of 2,000,000 BTU. Wherever the heat is most intense, type 430 Stainless Steel is used. It is especially important for the combustion chamber and emitting tubes.



FOR ARCHITECTURAL USE. This Dawson Floating Sill is made from type 302 Stainless Steel. It combines fine appearance with the enduring properties of Stainless Steel. The finished job is neat and trim, and it will last as long as the building.

UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS
PIPE · TUBES · WIRE · SPECIAL SECTIONS

USS

UNITED STATES STEEL

TORRINGTON *SPHERICAL ROLLER* BEARINGS

This bearing can take thrust, too!

Design is the secret. TORRINGTON Spherical Roller Bearings are made with an integral center flange on the inner race. This assures *positive radial stability and accurate positioning of rollers* wherever high radial load and heavy thrust are encountered under conditions of misalignment.

From crushers to cranes, power shovels to pulverizers, you get long, maintenance-free operation, better performance in your equipment, more value from your bearing dollar when you specify these rugged dependable bearings.

Prove to yourself that TORRINGTON design does make a difference. Next time specify TORRINGTON Spherical Roller Bearings. They're available with either straight or tapered bore, for shaft or adapter mounting.

THE TORRINGTON COMPANY

South Bend 21, Ind. • Torrington, Conn.

District offices and distributors in principal cities of United States and Canada

90th ANNIVERSARY

TORRINGTON BEARINGS

Spherical Roller • Tapered Roller • Cylindrical Roller Needle • Ball • Needle Rollers

REVERE *Aluminum* *and the '56* PACKARD *Royal Look*

It is fitting that the new Packard, a car of royal distinction, should face the world with a grille that has the look of gold. It is, in fact, of gold-anodized aluminum,* so authentic in appearance that it cannot be told, by the eye alone, from 18 karat gold.

Here is far more than another advance in motor car styling. For this grille of Revere Aluminum not only lightens the front end but is strong and rust-proof, with a finish that will not tarnish or peel. Aluminum is the only metal that lends itself so perfectly to finishing of this type. The hues of the rainbow and more are attainable . . . but the aluminum, itself, must be right. The choice of Revere Aluminum for this exacting function is a further indication of how thoroughly Revere knows its A-B-C's in metals—"A" for Aluminum, "B" for Brass, "C" for Copper.

If you are using aluminum or planning to, you can turn to Revere with confidence for sheet, tube, pipe, extruded shapes, bus conductors, forgings and foil. Why not call the nearest Revere office now? In all principal cities. Revere Copper and Brass Incorporated, Founded by Paul Revere in 1801. Executive Offices: 230 Park Avenue, New York 17, N. Y.

*Grille is of Revere Aluminum Sheet. Before anodizing to give it the gold color and protective coating, it is skilfully perforated by The Harrington & King Perforating Co. of Chicago; and accurately formed by Automotive Stamping & Manufacturing Co. of Detroit.

WE ROLL METAL

for scales that can detect the missing dot from an "i"

• Scale makers have borrowed a new kind of alloy used for springs in the finest watches—metal far springier than the finest steel. We call it Nilcor* . . . and produce it in widths from ⅛" to 1⅜", .0025" to .025" thick.

It's so hard and tough that only the finest, most advanced mill equipment and techniques can process it. Yet it is the most perfect material known for making the precision torsion bands used in laboratory scales . . . with more precise characteristics . . . greater stability . . . unmatched resistance to corrosion . . . longer life under repetitive bending.

Despite the difficulty of working Nilcor, the *Athenia Steel Division* of National-Standard gives it up to an 85% reduction and maintains tolerances as close as .0001".

It is this kind of ability that enables Athenia to develop practical applications of unique Nilcor and also makes Athenia a foremost supplier of special high carbon strip steel.

If you think you have a particular application requiring Nilcor, or if you need strip steel with unusual demands for tolerance, flatness, edge forming, uniformity, temper and other characteristics, try *Athenia*. And remember, small company or big company, we are eager to serve you. Write us.

*Trade Mark, National-Standard Company.

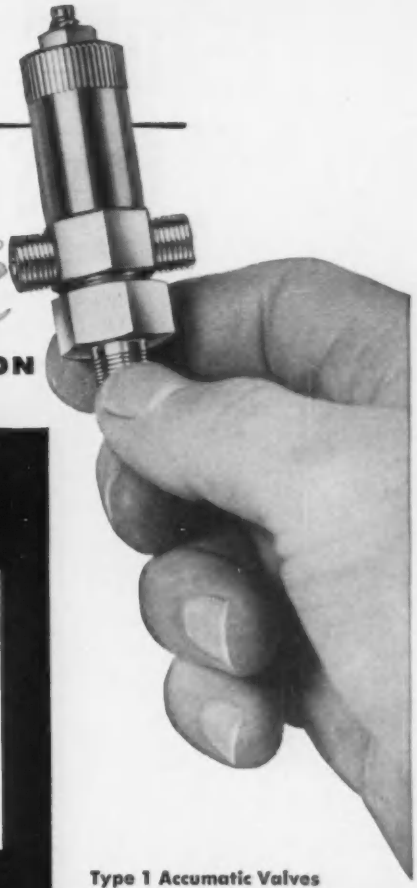
NS
NATIONAL-STANDARD Company
NILES, MICHIGAN

NATIONAL-STANDARD COMPANY • NILES, MICHIGAN
Tire Wire, Stainless, Fabricated Braids and Tape
ATHENIA STEEL DIVISION • CLIFTON, N. J.
Flat, High Carbon, Cold Rolled Spring Steel
REYNOLDS WIRE DIVISION • DIXON, ILLINOIS
Industrial Wire Cloth
WAGNER LITHO MACHINERY DIVISION • JERSEY CITY, N. J.
Special Machinery for Metal Decorating
WORCESTER WIRE WORKS DIVISION • WORCESTER, MASS.
Round and Shaped Steel Wire, Small Sizes

How to design with...

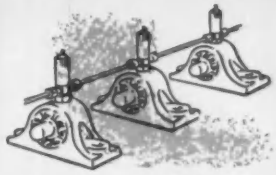
ALEMITE Accumatic®

CENTRALIZED AUTOMATIC LUBRICATION

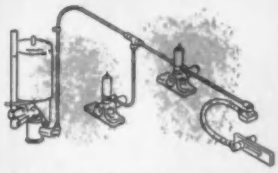


Can be built into any machine, in 4 easy steps

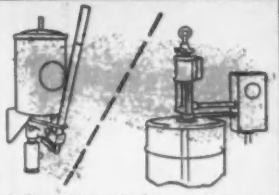
1. Replace grease cups or grease fittings with Accumatic fittings. (Available in same thread sizes as grease fittings, cups.)



2. Connect Accumatic fittings with copper tubing. (Alemite has tubing, clips and accessories for fast, neat installation.)



3. Connect sliding, rotary or oscillating parts into tubing system. (Flexible hose and swivels available for moving parts.)



4. Provide central pump to supply lubricant to system. (May be ordinary hand pump or fully automatic barrel pump.)

Type 1 Accumatic Valves

For fluid oil or light grease. In range of sizes, delivering from .005 to .100 cu. in. of lubricant. Various shapes: Tees, straight-thru, inserts, angles. Spring pressure provides gradual feed. Adjustable or fixed output. System serves up to 400 bearings. Manual or automatic operation available.

Factory-tested—field-proved!

Exhaustive in-the-field tests show no appreciable variation in the amount of lubricant discharged after 73,312 lubrication cycles—equal to 122 *years* of *twice-a-day service!*

Offers All These Advantages!

- Prevents application of wrong lubricant.
- Seals completely against dirt, grit, water.
- No parts are neglected—lubricates inaccessible and dangerous bearings.
- Eliminates product spoilage due to over-lubrication.
- Eliminates point-by-point lubrication methods—services all bearings in one operation.
- Delivers *exact* amount of lubricant to bearing.

ALEMITE

REG. U. S. PAT. OFF.

A Product of STEWART-WARNER CORPORATION

A PRODUCT OF SW STEWART WARNER

FREE!

Alemite, Dept. T-46

1850 Diversey Parkway, Chicago 14, Illinois

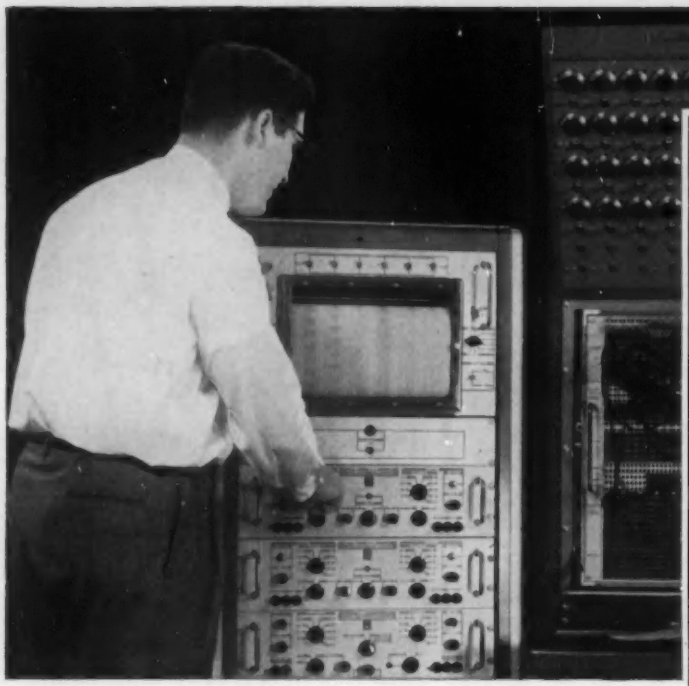
Please send me my free copy of the Alemite Accumatic Catalog.

Name.....

Company.....

City.....State.....

WHY LEADING DEVELOPMENT GROUPS CHOOSE BRUSH RECORDING SYSTEMS



VERSATILE!

Systems may be mounted in mobile instrument carts, racks, or consoles.

Portable instruments are lightweight, rugged and accurate.

Mobile instrumentation center in station wagon.

In exacting military programs, and in a broad range of industrial and research applications, leading engineering groups use and prefer Brush Recording Systems... because they offer these exclusive advantages:

- **accurate recording of phenomena from d. c. to 100 cps in an immediately usable form.**
- **widest range of chart recording speeds in one instrument, from 10″ per day to 10″ per second. Instantaneous selection of any of 16 chart speeds provides excellent readability for a wide range of signals.**
- **choice of ink writing (for chart paper economy and easy reproducibility) and electric writing (for remote monitoring, etc.).**

• To help speed your testing and development, get the facts with Brush Systems. For complete information, write Brush Electronics Company, Dept. L-4, 3405 Perkins Avenue, Cleveland 14, Ohio.

BRUSH ELECTRONICS COMPANY

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZOELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT AND COMPONENTS

BRUSH ELECTRONICS

Division of Clevite Corporation

A New Line

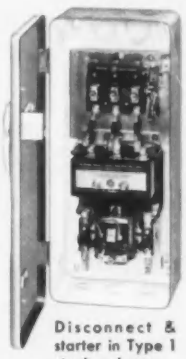
OF BULLETIN 712 COMBINATION STARTERS

Allen-Bradley announces a modernization of its Bulletin 712 combination starters that should meet with the instant approval of plant "safety" organizations. The cover cannot be opened unless the operating lever is in the "off" position; also the movable disconnect contacts are **plainly visible** when this switch is "open." A welded or sticking contact can be detected instantly. The new operating lever contains a concealed latch pin which permits the maintenance man to open the cabinet without opening the disconnect and stopping the motor. Disconnect switch can be padlocked with three locks—in the open position. It can be arranged for padlocking in running position.

SIZE 1

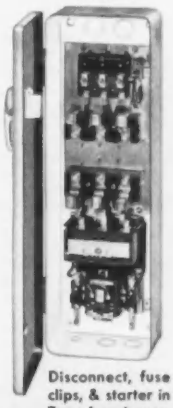
Disconnect, transformer, & starter in Type 12 cabinet.

SIZE 2



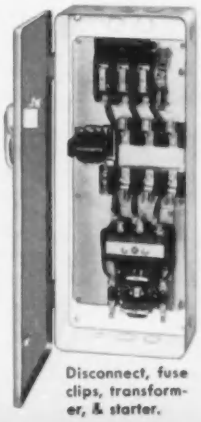
Disconnect & starter in Type 1 steel enclosure.

SIZE 2



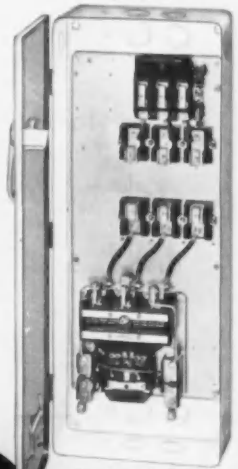
Disconnect, fuse clips, & starter in Type 1 enclosure.

SIZE 3



Disconnect, fuse clips, transformer, & starter.

SIZE 4



Disconnect, fuse clips, & starter in Type 1 enclosure.

Allen-Bradley Co.
1316 S. Second St.
Milwaukee 4, Wis.

In Canada—
Allen-Bradley Canada Ltd.
Galt, Ont.

A-B Quality

ALLEN-BRADLEY

QUALITY

TROUBLE FREE MOTOR CONTROLS

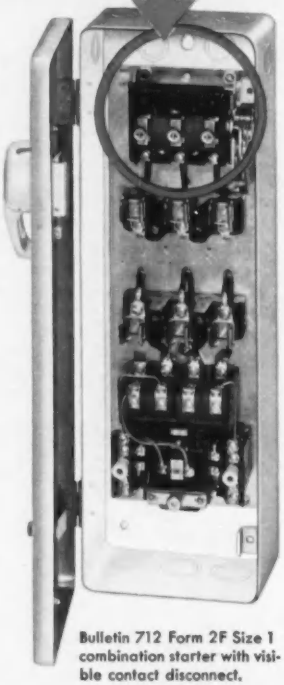
4-56-MR

NEW! The first disconnect switch with movable contacts that are plainly visible in the OFF position

Allen-Bradley has finally succeeded in producing a disconnect switch, which removes all doubt whether the movable contacts are in the "open" or "closed" position. When in the "open" position, they are plainly visible—as open; when in the "closed" position, they are dropped—out of sight in the arc hood.

The moving, double break contacts of the new disconnect (shown in yellow above) move horizontally in individual arc chambers. When the disconnect is CLOSED, the moving contacts are DOWN in the arc chambers. In the OPEN position the moving contacts are UP in plain view, as shown in the colored illustration directly above.

If a contact should stick or weld, it will fail to rise to its "open" position and thereby indicate that the respective "link" remains closed—a plainly visible warning signal to the maintenance man.



Bulletin 712 Form 2F Size 1 combination starter with visible contact disconnect.

A unique feature of the new line are the interlocks built into the disconnect lever.

First—the disconnect lever is interlocked with the door latch so that the door cannot be opened unless the lever is in the OFF position. This assures that the starter is "dead" when the cabinet is open and is safe to inspect.

Second—the disconnect lever has a concealed release pin used only by authorized persons for opening the cabinet door, if needed, without shutting down the motor.

Standard operating lever permits use of one to three padlocks to lock in "off" position, but also can very simply be changed to permit padlocking in "on" position.

These new Bulletin 712 combination starters are available in NEMA Type 1, 4, 7, 9, and 12 enclosures. They are listed from 1 to 100 hp, 220 v; 200 hp, 440-550 v.

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis. • In Canada—Allen-Bradley Canada Ltd., Galt, Ont.

A-B

ALLEN-BRADLEY

TROUBLE FREE MOTOR CONTROLS

QUALITY

4-56-MR

Data Courtesy Rodic Chemical & Rubber Corp., New Brunswick, N. J.

Biggest Silicone Rubber Roll made possible by unique compound

What! Silicone rubber in thick sections? It couldn't be done! But today *it is done* with a new UNION CARBIDE Silicone Rubber Compound. Witness the product in the accompanying picture—a silicone rubber roll 55 inches long by 8 inches in diameter—believed the largest ever built.

Most astonishing of all: The costly, step-by-step curing cycles, once necessary to prevent blowing and delaminating, give way to a one-step cure.

You might find a use for such a roll in a paper mill, or in textile machinery, where non-sticking qualities are important. You might find other uses for UNION CARBIDE Silicone Rubber and Compounds for products that must remain flexible at very low temperatures, resist high heat, provide extremely low compression set, or offer resistance to ozone, corrosive atmospheres, or electricity.

Besides silicone rubbers, UNION CARBIDE is a leading producer of silicone electrical insulation resins, of silicone release agents, and silicones for water repellents. The combined experience of UNION CARBIDE and its various Divisions can assist you in their application. Call us in, today.

"UNION CARBIDE" SILICONES TRADE MARK
formerly
"LINDE" SILICONES TRADE MARK

SILICONES DIVISION

UNION CARBIDE
AND CARBON CORPORATION

30 EAST 42ND STREET UCC NEW YORK 17, N. Y.

In Canada: Linde Air Products Company, Division of Union Carbide Canada Limited

The term "Union Carbide" is a trade-mark of Union Carbide and Carbon Corporation

Silicones Division, Dept. P-4.
UNION CARBIDE AND CARBON CORPORATION
30 East 42nd Street, New York 17, N. Y.

Please send me data on Silicones for:

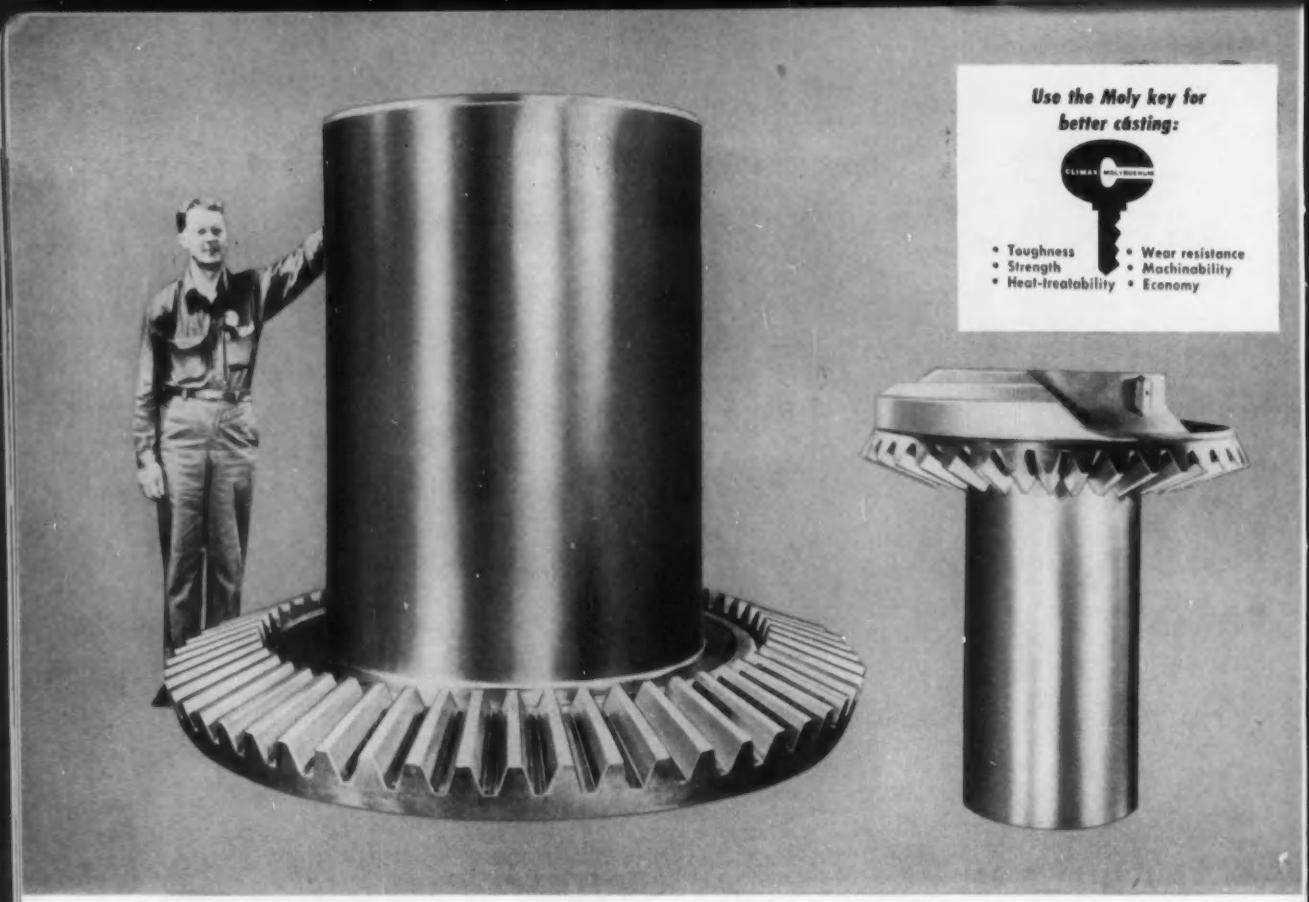
☐ Rubber Rolls ☐ Class H Electrical Insulation
☐ Release Agents ☐ Rubber Gum Stock and Compounds

*Name*_____ *Title*_____

*Company*_____

*Address*_____

*City*_____ *Zone*_____ *State*_____

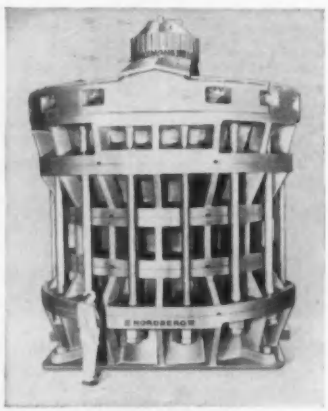


Heavy duty ore crushing machinery is subjected to severe operating conditions. To meet these strenuous requirements the gears shown are made from heat treated low-alloy manganese-*Molybdenum* steel castings. At left: a Symons Gyratory Crusher gear; right: a Symons Cone Crusher gear. Built by Nordberg Mfg. Co.

Cast Manganese Moly Steel contributes strength and toughness to Crushers built by Nordberg

"Where high strength and toughness are prime considerations," says Howard Zoerb, Consulting Engineer of the Nordberg Crusher Division, "molybdenum bearing steels are specified. This is true of the heavy duty parts of Symons® Crushers, built by Nordberg. These steels have contributed to the Nordberg reputation as producers of dependable, heavy duty crushing machinery."

Technical assistance is available to foundries on alloying problems. Please address inquiries on your foundry letterhead to: Climax Molybdenum Company, Department MF61, 500 Fifth Avenue, New York 36, New York.



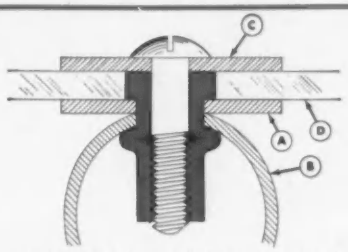
The Symons Cone Crusher is a product of Nordberg Manufacturing Company.

CLIMAX MOLYBDENUM

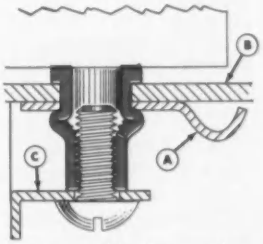
B.F. Goodrich Rivnut

cuts fastening time, saves money by doing two jobs in one operation!

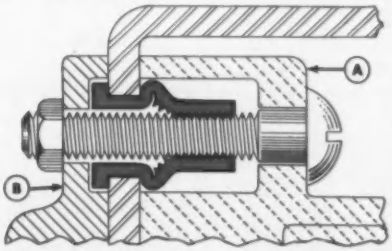
Do you have dual fastening problems like these?



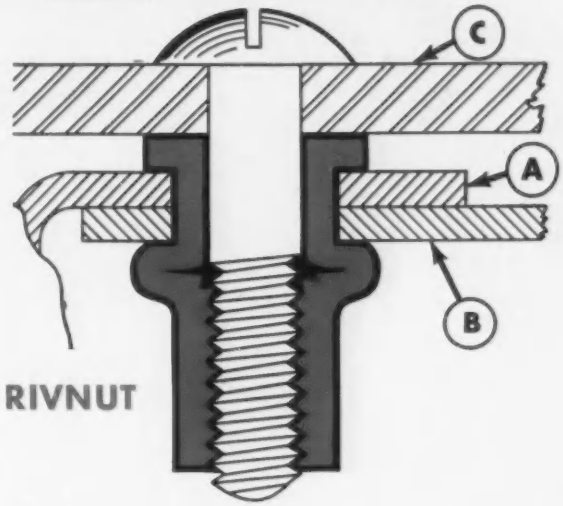
In airplane window seal, Rivnut rivets plate (A) to center post (B), provides nut plate to hold clamp strip (C). Rivnut head serves as spacer for transparent plastic sheets (D). Result: a neat, weather-tight seal!



In vaporizer assembly, Rivnut rivets upper flange (A) to casing (B), makes firm, accurate nut plate for attachment to lower flange (C). Rivnut eliminates reinforcing plate. Result: less assembly time, fewer parts, better product.



Rivnut provides 6-thread nut plate for attachment from either end—or *both*. In spotlight assembly, Rivnut replaces awkward welded stud for attaching socket (A). Plug base (B) is attached on other side. Result: fewer operations, lower assembly cost.



B. F. GOODRICH RIVNUTS cut costs and speed assembly because they rivet two parts together, make a firm, accurate nut plate for a third. And they do both jobs in one quick operation! Rivnuts can be installed from one side, take an attachment bolt from either end. They eliminate welding, tapping, clinching.

In the transformer assembly above, one worker fastens the metal cover (A) to the plastic sheet (B) with Rivnuts in seconds. Rivnuts then serve as mounting lugs for attaching completed transformer to mounting plate (C).

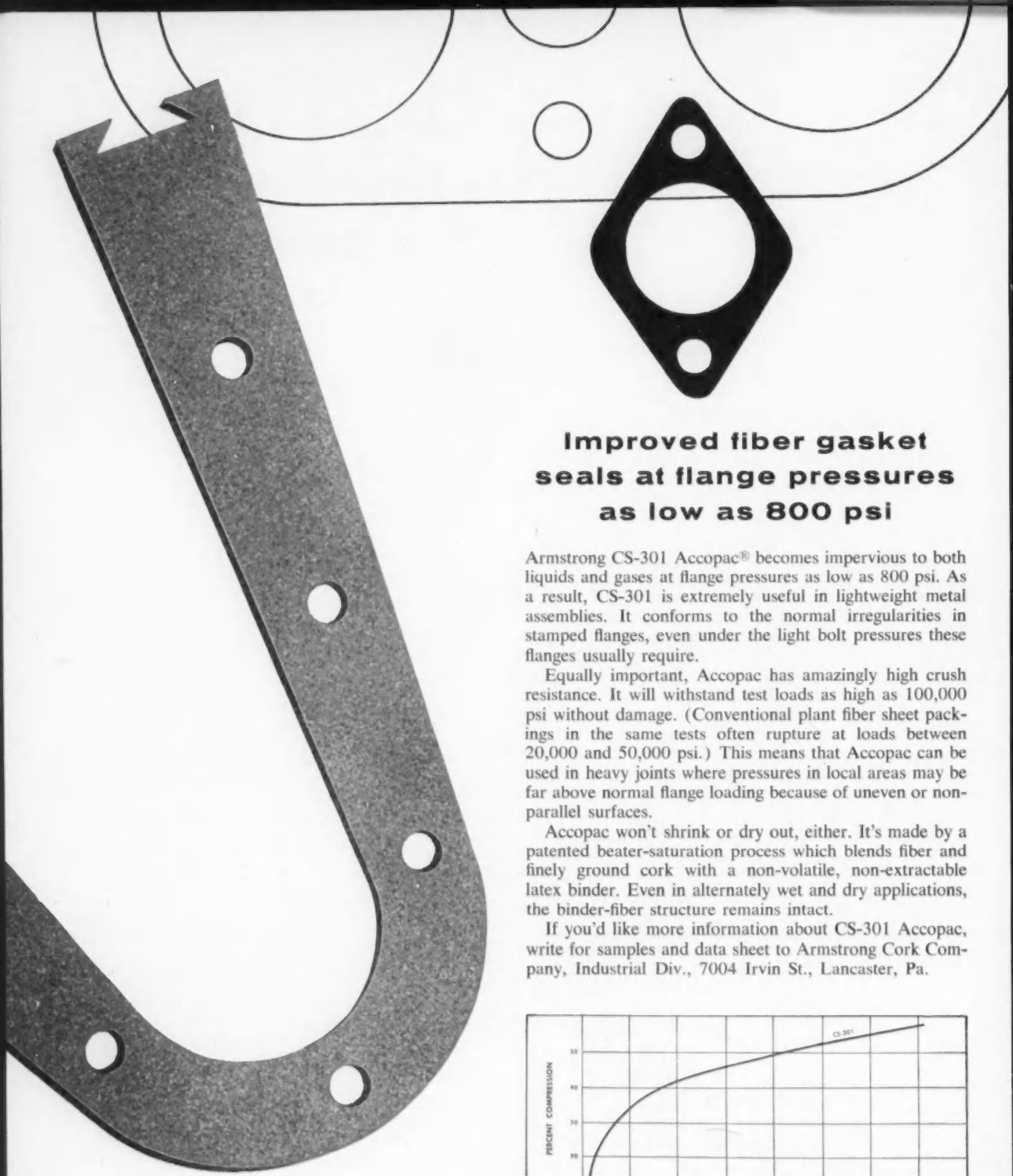
B. F. Goodrich Rivnuts have speeded up thousands of fastening jobs—can do the same for you. Write today to *B. F. Goodrich Company Tire & Equipment Division, Rivnut Sales, Akron, Ohio.*

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how you can use Rivnuts to fasten WITH and TO. Explains construction, simplicity of installation. Get your free copy today by writing to: The B. F. Goodrich Company, Dept. PE-46, Akron, Ohio.

B.F. Goodrich RIVNUTS

The only one-piece blind rivet with threads



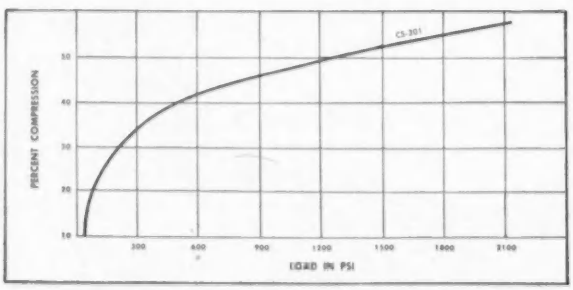
Improved fiber gasket seals at flange pressures as low as 800 psi

Armstrong CS-301 Accopac® becomes impervious to both liquids and gases at flange pressures as low as 800 psi. As a result, CS-301 is extremely useful in lightweight metal assemblies. It conforms to the normal irregularities in stamped flanges, even under the light bolt pressures these flanges usually require.

Equally important, Accopac has amazingly high crush resistance. It will withstand test loads as high as 100,000 psi without damage. (Conventional plant fiber sheet packings in the same tests often rupture at loads between 20,000 and 50,000 psi.) This means that Accopac can be used in heavy joints where pressures in local areas may be far above normal flange loading because of uneven or non-parallel surfaces.

Accopac won't shrink or dry out, either. It's made by a patented beater-saturation process which blends fiber and finely ground cork with a non-volatile, non-extractable latex binder. Even in alternately wet and dry applications, the binder-fiber structure remains intact.

If you'd like more information about CS-301 Accopac, write for samples and data sheet to Armstrong Cork Company, Industrial Div., 7004 Irvin St., Lancaster, Pa.

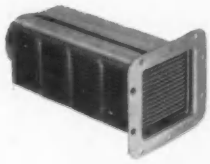


HIGH COMPRESSIBILITY of Accopac CS-301 is shown by load-compression curve. With light metal flanges, this compressibility allows gaskets to conform to surface irregularities and seal without distorting flange.

Armstrong ACCOPAC

. . . used wherever performance counts

COOL CROSSING



HARRISON KEEPS TEMPERATURES LEVEL ON POPULAR CIRCLE LINE FERRY BOAT

It's always smooth sailing . . . when Harrison drops anchor on the heat! Harrison heat exchangers keep operating temperatures at bay on today's high-powered marine diesels . . . assure cool performance with top efficiency and economy, even under heavy loads. You'll find Harrison specified in every line of industry—and national defense—from dump trucks to jet fighter planes . . . from hydraulic presses to submarines. That's because Harrison's 45 years' experience in design, research and manufacture pays off in top-quality heat control products. If you have a cooling problem, look to Harrison for the answer.

GM GENERAL MOTORS

HARRISON

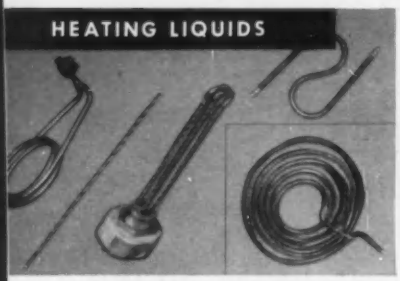
RADIATOR DIVISION, GENERAL MOTORS CORP., LOCKPORT, N.Y.

TEMPERATURES MADE TO ORDER

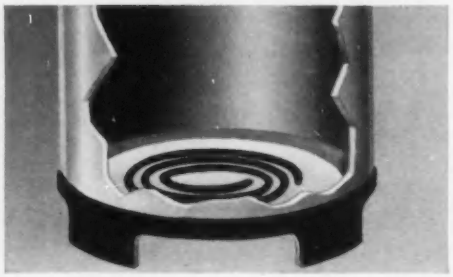
DESIGNING HEAT INTO YOUR PRODUCT?

G-E Heaters Can Be Formed to Your Exact Design; Big Selection Saves You Design and Production Time

HEATING LIQUIDS



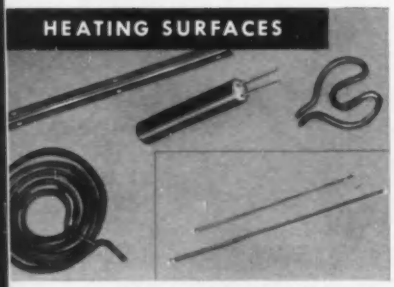
1 **SIMPLIFIED DESIGN** and easy installation benefit maker of cement tester, who chose sturdy, flexible G-E tubular heaters.



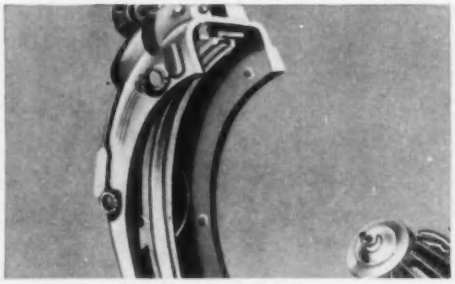
2 **SPACE LIMITATION** is easily overcome with General Electric tubular heaters, which can be formed readily to practically any shape . . . without danger of breaking.

3 **G-E TUBULAR HEATERS** simplify tester use. To begin test, operator need only plug in tester, load specimens, and turn on switch.

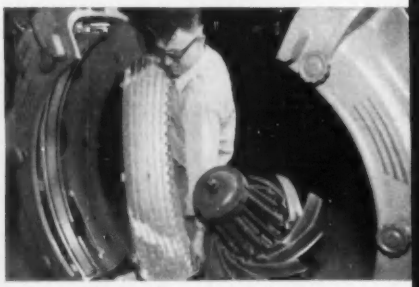
HEATING SURFACES



1 **FLEXIBLE BUT RUGGED** G-E tubular heaters are chosen by tire-retreader manufacturer after test. Other makes broke when formed.

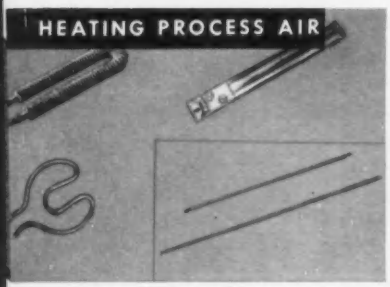


2 **GENERAL ELECTRIC** tubular heaters bend easily to the curved shape of tire retreader. Heaters are inserted into grooves in heating plate to gain maximum heat transfer.

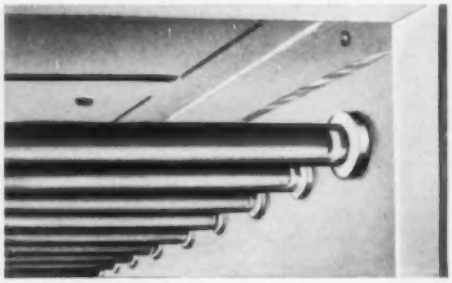


3 **EXACT HEAT** required for top-quality retreading of huge truck tires is achieved with high-efficiency General Electric heaters.

HEATING PROCESS AIR



1 **RAPID INSTALLATION** is one benefit of uncomplicated design. Designer used straight-length tubular heaters in pre-heat oven.



2 **COMPACT DESIGN** of pre-heat oven is possible with inside-mounted General Electric tubular heaters, which replaced outside, top-mounted heaters formerly used.

3 **UNIFORM HEAT** throughout oven combines radiation and convection, since tubular heaters are mounted inside oven chamber itself.

Section A723-9, General Electric Company,
Schenectady 5, N. Y.

Name .....

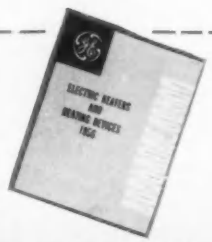
Company .....

Street .....

City ..... State .....

FREE

60-page Catalog of General Electric heaters and heating devices—describes full line. Also provides helpful application data. GEC-1005G.



GENERAL ELECTRIC

All off-the-highway earth-moving equipment... dozers, scrapers, dump trucks... pose special hydraulics problems. The bulk, tonnage, and rugged service impose conditions that shoot an "ordinary" or "standard" formula full of holes. This is true of all heavy-duty equipment and especially so with long-stroke telescopic cylinders!

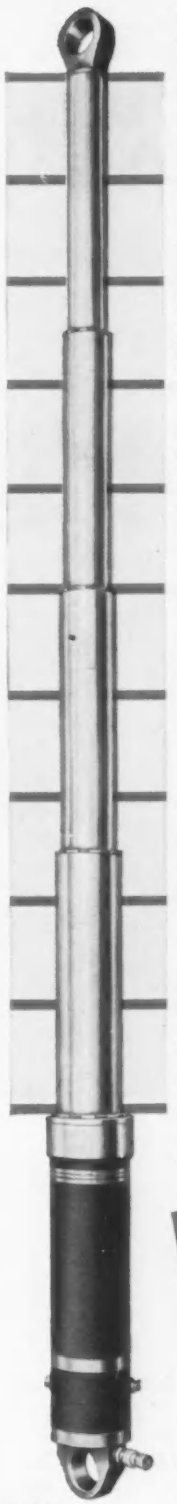
HYDRECO®

LONG-STROKE HYDRAULIC TELESCOPIC CYLINDERS

HYDRECO Cylinders are the result of many years of design and production experience. They're custom built for the service they face. They can be designed to meet your special requirements of space, mounting, function and load. You can have HYDRECO Cylinders with strokes to 20 feet or more and for loads requiring outer sleeves as large as 10 inches in diameter and system pressures to 1500 psi.

Telescopic cylinders are tough to build. No other cylinder calls for such close tolerances and perfect finish... no other type requires so much in design and production "know-how." Engineers who want "the bugs" out of their heavy-duty mobile equipment from the start specify HYDRECO!

Whether your problem involves 1 ton or 75 tons, the broad experience of HYDRECO engineers in finding the *right* answer can save you time, money and grief.



Write

—let HYDRECO engineers show you how you can improve your equipment with custom-built HYDRECO Telescopic Cylinders.

Member NFPA

KALAMAZOO DIVISION
THE NEW YORK AIR BRAKE COMPANY

9012 E. MICHIGAN • KALAMAZOO • MICH.

INTERNATIONAL SALES OFFICE, 90 WEST ST., NEW YORK 6, N. Y.

BIG DART EQUIPMENT SPEEDS CONSTRUCTION

OFF-THE-ROAD DUMP TRUCKS CARRY 75 YARDS PER LOAD

It's no problem at all to carry away, in a single load, half the dirt from an average home basement excavation. Modern off-the-highway dump trucks, hauling 75 tons or more of earth and over-burden, make short work of moving a hill or filling a valley.

Dumping these giant loads is done by means of big Telescopic Hydraulic Cylinders. Because truck bodies are so large, they require cylinders of unusually long stroke and capacity to raise them to full dumping position. During this operation it's an absolute "must" that all sleeves extend smoothly with no sticking or binding. Above all, safe operation is essential.

Downtime with this equipment costs big money. These giant trucks run day and night, rain or shine, on all sorts of jobs — so, cylinder maintenance must be negligible. Many truck builders have made these big models practical and profitable with HYDRECO Fluid Power. Their experience has shown that HYDRECO Cylinders do the job and that they're safe, smooth operating and require a minimum of maintenance.

One of these builders is the Dart Truck Company, Kansas City, Mo., whose new 75-Ton capacity dump body is shown here. This model uses two 120-inch stroke HYDRECO Telescopic Cylinders. Fluid Power for the circuit is provided by two HYDRECO Pumps and control is by means of a HYDRECO Hollow-Plunger Valve.

ENGINEERS

Exceptional opportunities for men of imagination to express new ideas in the design and development of Fluid Power Components. Company expansion and progress promise rewarding futures for engineers who qualify. Write, giving experience and full details.

KALAMAZOO Division
The New York Air Brake Company
9012-4 E. Michigan, Kalamazoo, Mich.

Gentlemen: We'd like to discuss the subject of Telescopic Cylinders with one of your engineers. We understand there is no cost or obligation for this cooperation.

Name_____

Company_____

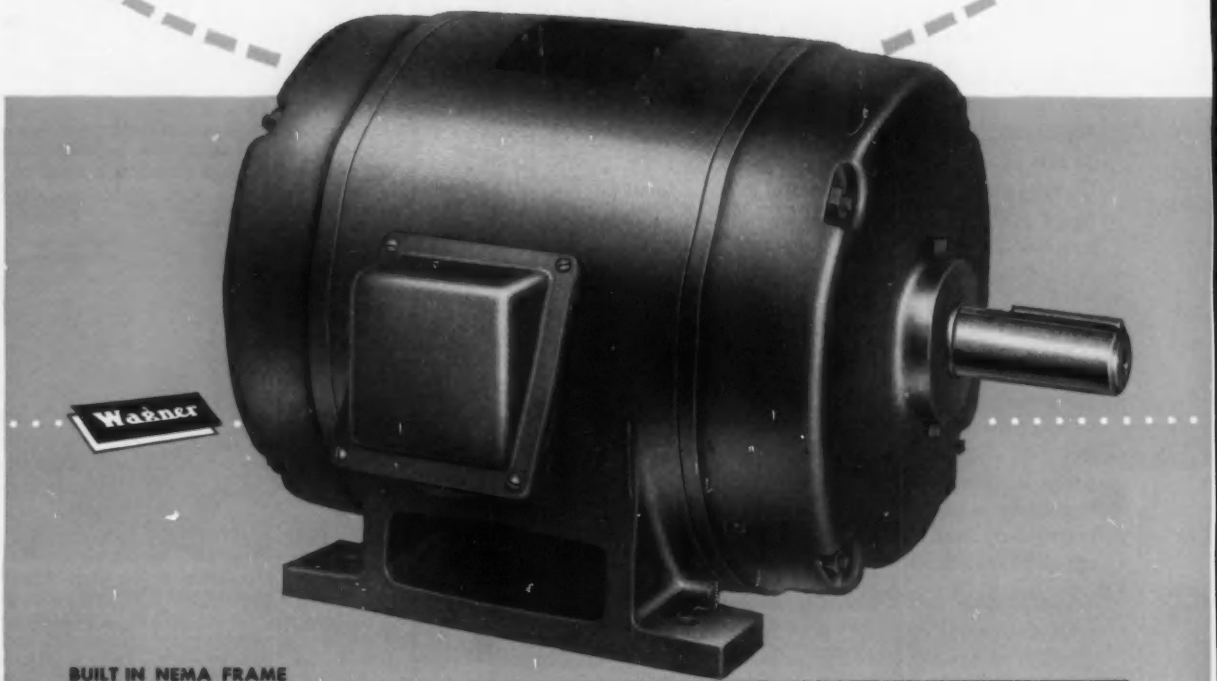
Address_____

City_____ Zone____ State_____

Wagner **ELECTRIC MOTORS...the choice of leaders in Industry**

You get better performance with these New Wagner DP Motors

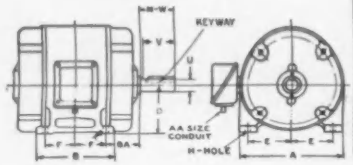
DOUBLY-PROTECTED



BUILT IN NEMA FRAME SIZES—182 THROUGH 326 U

HP	Frame No.	Key Width	Key Thickness	Key Length	A max.	B max.	D	E	F	BA	H	N-W	U	V min.	AA min. size of cond't
1	182	3/16	3/16	1 3/8	9	6 1/2	4 1/2	3 3/4	2 1/4	2 3/4	13/32	2 1/4	7/8	2	3/4
1 1/2	184	3/16	3/16	1 3/8	9	7 1/2	4 1/2	3 3/4	2 3/4	2 3/4	13/32	2 1/4	7/8	2	3/4
2	184	3/16	3/16	1 3/8	9	7 1/2	4 1/2	3 3/4	2 3/4	2 3/4	13/32	2 1/4	7/8	2	3/4
3	213	1/4	1/4	2	10 1/2	7 1/2	5 1/4	4 1/4	2 3/4	3 1/2	13/32	3	1 1/8	2 3/4	3/4
5	215	1/4	1/4	2	10 1/2	9	5 1/4	4 1/4	3 1/2	3 1/2	13/32	3	1 1/8	2 3/4	3/4
7 1/2	254U	5/16	5/16	2 3/4	12 1/2	10 3/4	6 1/4	5	4 1/8	4 1/4	17/32	3 3/4	1 3/8	3 1/2	1
10	256U	5/16	5/16	2 3/4	12 1/2	12 1/2	6 1/4	5	5	4 1/4	17/32	3 3/4	1 3/8	3 1/2	1
15	284U	3/8	3/8	3 3/4	14	12 1/2	7	5 1/2	4 3/4	4 3/4	17/32	4 3/8	1 3/8	4 3/8	1 1/4
20	286U	3/8	3/8	3 3/4	14	14	7	5 1/2	5 1/2	4 3/4	17/32	4 3/8	1 3/8	4 3/8	1 1/4
25	324U	1/2	1/2	4 1/4	16	14	8	6 1/4	5 1/4	5 1/4	21/32	5 3/8	1 7/8	5 3/8	1 1/2
30	326U	1/2	1/2	4 1/4	16	15 1/2	8	6 1/4	6	5 1/4	21/32	5 3/8	1 7/8	5 3/8	1 1/2

FRAME SIZES AND DIMENSIONS
1 to 30 H. P.



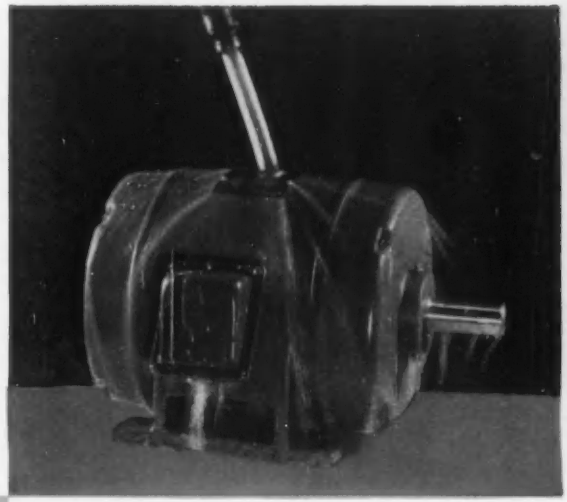
Wagner Electric Corporation EST. 1891

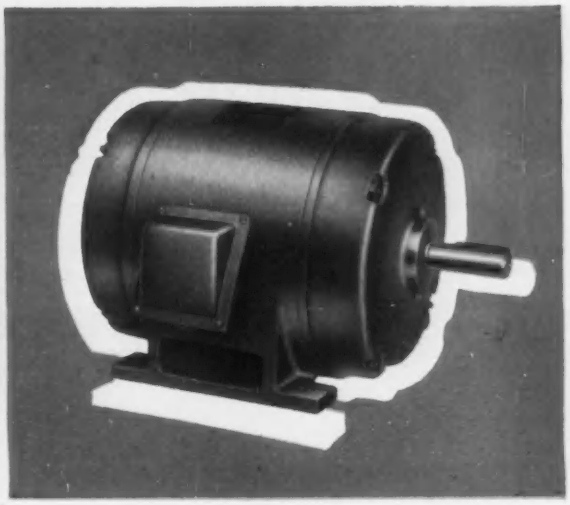
WAGNER ELECTRIC CORPORATION
6406 Plymouth Ave. • St. Louis 14, Mo., U. S. A.

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS — AIR AND HYDRAULIC

Visit our Booth No. 437, DESIGN ENGINEERING SHOW
Philadelphia, May 14-17.

M56-1



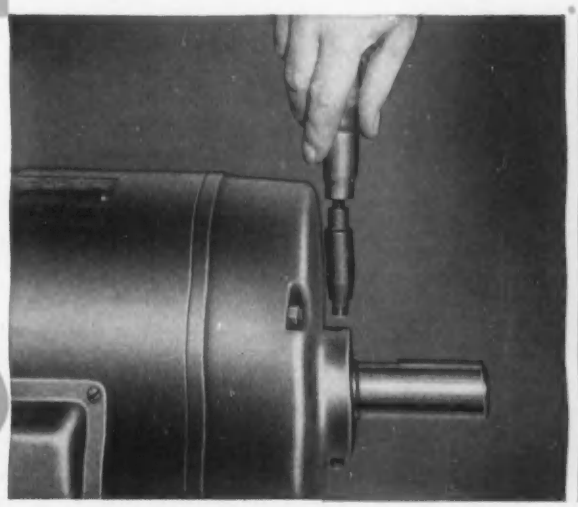


DOUBLY PROTECTED—Wagner DP Motors are protected by (1) rugged, corrosion-resistant cast iron frames, smoothly rounded so that no moisture can collect on them. Motor feet are cast as an integral part of the frame for maximum strength and rigidity. (2) Enclosures on the DP motor are completely drip-proof—virtually splashproof. Air intakes are located at the bottom of the endplates and air outlets are located at the base of the frame—one on each side.

MORE POWER IN SMALLER FRAMES—Wagner DP Motors are engineered to the new NEMA specifications which call for more power in smaller frames. The Wagner DP Motor packs more power in a smaller frame, but gives you the same quality and long life performance that have made Wagner Motors "the choice of leaders in industry" for many years. This smaller size means ease of handling and stocking . . . less space required for installation.

CAN BE RE-GREASED FOR LONGER LIFE—Wagner DP Motors will operate for years without re-greasing . . . the bearings are completely enclosed . . . however, provisions have been made for adding lubricant and for the removal of old grease in applications where re-greasing is necessary to prevent premature bearing failure—due, in most cases to inadequate lubrication rather than to inability to carry the load.

COOL RUNNING—Specially designed baffles direct cooling air from the blowers through the motor and provide protection for the stator windings. Blowers are cast as an integral part of the rotor squirrel-cage and are designed to move large volumes of air without vibration or objectionable noise. Cool running motors last longer.



NEW! Heavy-duty relay in small space

This new CLARK Type "PM" Control Relay introduces a new concept in relay design: *Sectional Pole Construction.*

In this new relay, each pole is contained in its own melamine housing, and any individual pole can be removed or replaced from the front without disturbing the others. A short circuit is confined to a single pole and will not destroy the whole relay. Wiring terminals are on the front, and all maintenance including coil changing, pole or magnet replacement, is also from the front—without removing relay from panel. Contacts are quickly and easily convertible from normally open to normally closed and vice versa—from the front. Range of models provides relays with 2 to 12 poles. Exclusive design allows more contacts per square foot of panel space. In addition to the many advantages of SECTIONAL POLE CONSTRUCTION, you get a *heavy-duty relay in small space.*

For complete information write to

The CLARK CONTROLLER *Company*

Engineered Electrical Control

1146 East 152nd Street • • Cleveland 10, Ohio

IN CANADA...CANADIAN CONTROLLERS, LIMITED • MAIN OFFICES AND PLANT, TORONTO

which part should be made of metal powder?

We ask: **How will it be used in the end product of which it will be a component?** What are the loads, tolerances, and shape of the individual part? How will it be lubricated? Are there any special requirements such as hardness and finish? Do the quantities justify tooling costs?

These are the questions that were answered before any decisions were made on the parts shown above —both of which are made of metal powder.

Because Moraine Products can draw upon a wide range of experience with many different mass production processes and their applications to specific problems, our judgment on these questions can be considered sound. When we recommend metal powder, it is because we are convinced, in our own minds, that it is the material and the process best suited for the job the specific part must do.

Other Moraine Products include: Moraine power brakes—Delco hydraulic brake fluids, brake assemblies, master cylinders, wheel cylinders and parts—Moraine friction materials—porous metal parts—rolled bronze and bi-metal bushings—self-lubricating bearings, Moraine-400 and M-100 automotive engine bearings.

Another General Motors Value

Moraine Products
Division of General Motors, Dayton, Ohio

JACK OF ALL TRADES... AND MASTER OF EACH!

New WILCOTROL SERIES G

Here is a versatile new thermostat for both heating and cooling applications... higher rated for new heavy-duty appliances and medium industrial requirements. Interchangeable with former Model F, the new Series G provides for differential factory adjusted to customer's specification, simplified calibration adjustment, and a contact mechanism not affected by vibration.

Other new features include screw type or quick connect terminals, Positive Off Position-Type G-1 (heater load). "Constant cool" position optional on Type G-2 (cooler load). Universal mounting bracket, and terminal cover where required. For full information on the new Series G, contact The Wilcolator Co., 1001 Newark Ave., Elizabeth, N. J. Canadian plant: Mimico, Toronto, Canada.

SPECIFICATIONS:

Standard temperature range: 40°F Minimum, 550°F Maximum.
Special temperature ranges: to customer's requirements
Type G-1: Contacts open on temperature rise
Type G-2: Contacts close on temperature rise
Switch Mechanism: Single pole, double break, snap action
Contact Rating: Type G-1 30 Amp. 125 and 250 volts—AC non-inductive load
Motor Ratings: Type G-2

VOLTS	RUNNING CURRENT	LOCKED ROTOR
120 AC	14 AMP	60 AMP
208 AC	14 AMP	60 AMP
240 AC	14 AMP	60 AMP

Both motor and non-inductive ratings Underwriters listed and approved.
Mounting: Back of panel or in enclosure
Terminals: Screw Type, AMP or Arkles. Standard shaft size—¼" flatted to .156". Length to customer's specification.

THE Wilcolator COMPANY

Design data on adhesives

Armstrong

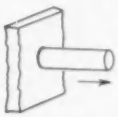
ADHESIVES • COATINGS • SEALERS

NUMBER TWO

Strengthening a common angle joint

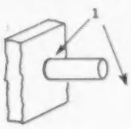
In redesigning a common angle joint (or any other ordinary joint) to give maximum strength with adhesives, four basic rules must be kept in mind.

1. Make the bonded area as large as possible.
2. Make the maximum proportion of bonded area contribute to strength.
3. Stress the adhesive in the direction of its maximum strength.
4. Minimize stress in the direction in which the adhesive is weakest.



Here's how these rules can be applied: If the load is in the direction of the arrow, then stress distribution will yield high strength.

If the load is not exactly at right angles to the plane of the joint, the result will be a concentration of stress, a cleavage force (in this case at 1).

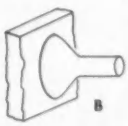


REMEDY

A. Increase area (better)

Bonded area has been made as large as possible. (Rule 1) Maximum proportion of bonded area now contributes to strength. (Rule 2)

B. Increase area and reduce stiffness at edge of joint (best)



Bonded area has been made as large as possible. (Rule 1) Maximum proportion of bonded area now contributes to strength. (Rule 2) Stress is now minimized in the direction in which the adhesive is weakest. (Rule 4)

For more information

Write for a copy of "Armstrong Adhesives, Coatings, and Sealers." Armstrong Cork Company, 8004 Irvin St., Lancaster, Penna.

How to prepare surfaces for bonding

To attain optimum results with adhesives, the surfaces of the materials to be bonded must be clean. The amount of surface preparation necessary may be influenced by the type of adhesive used or the ultimate requirements of the bond.

Nonstructural adhesives, such as the pressure-sensitive or contact types, rubber cements, and asphalt adhesives, perform satisfactorily if the surface is free of dust and dirt, grease and oil, loose scale and corrosion products.

Where high-strength bonds are required, surface preparation must be more thorough. Chemical cleaning is preferred where the size of the production operation warrants installation of the proper equipment. Mechanical methods are desirable on operations where the number of assemblies to be bonded is small or where chemical cleaning would cause deterioration of part of the assembly.

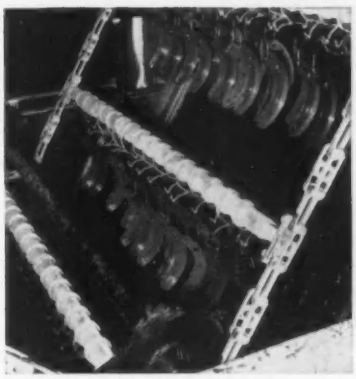


PHOTO COURTESY CHEVROLET-DETROIT GEAR AND AXLE DIV., GENERAL MOTORS CORP.

Before bonding, brake shoes are washed and pickled, then immersed in varnish dip and dried.

Listed below are typical procedures for cleaning materials frequently fastened by adhesives.

Aluminum may be cleaned with acidic or alkaline cleaners. Preferred alkaline cleaner of sodium metasilicate and a wetting agent in water at a temperature of 160° to 180° F. cleans aluminum in 4 to 5 minutes. Aluminum should be immediately rinsed with water. (A chromic acid rinse after alkaline cleaning prevents corrosion by residual alkali.)

Cleaning methods for spot welding are satisfactory for bonding. Preferable acidic cleaner consists of a solution of sulphuric acid and sodium dichromate at 140° to 160° F.

Steel should be free of rust and mill scale as well as dirt and grease. Use an alkaline cleaner to remove grease and dirt and follow with an acid pickling operataion. (Pickling of high-carbon steel and certain alloys often leaves a smut or residue which may be removed mechanically while wet or chemically with oxidizing agents.) Clean steel parts should be coated immediately to prevent rust formation.

Magnesium may be cleaned by brushing lightly with a fine wire brush followed by hot alkaline cleaner and water rinse, or by anodizing. Magnesium supplied with conventional surface treatments sometimes can be used as is, but surface contamination should be removed with solvent. Common practice in the aircraft industry, for example, is to clean the metal, apply coat of zinc-chromate primer, and bond right over it.

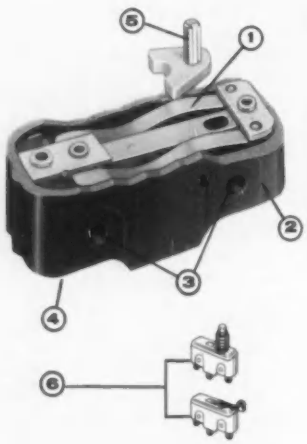
Plastics should be sanded prior to bonding to remove mold finish and mold release agents. Flexible vinyl plastic sheets normally require no cleaning other than surface dirt removal. Other plastics may be wiped with a solvent; however, true solvents for the plastic normally should not be used as they may cause distortion, excessive softening, crazing and cracking.

Vulcanized Rubber parts are often contaminated with mold release agents or by plasticizer or wax exudation. Silicone mold release agents prevent good bonds, as the silicone greatly impairs adhesion to the rubber. Remove talc and water-soluble mold-release agents by washing with water; plasticizer and wax, by washing with solvent. Solvent used depends on the specific rubber; toluol generally is satisfactory, but it should be used with care, since it attacks some types of rubber. Light abrasion of the rubber surface improves adhesion.

greater sensitivity...

PLUS EXTRA-LONG LIFE

a NEW precision basic switch By Illinois Tool Works



LICON* TYPE 10 BASIC SWITCH

with standard 1" mounting

Here's extreme sensitivity and extra-long life—both in one precision basic switch! Movement differentials as low or lower than .0005" can be had. Licon's new serpentine mechanism repeatedly has given ten million repetitions without failure. Fatigue problems and switch replacements are cut... performance improved. Made of the finest materials to highest quality standards. Licon has a variety of adapters for appliances, aircraft and in-plant equipment. Has 15 amp rating. Write for Licon Bulletin.

1. **New Serpentine Snap-Action Switch Blade**
2. **Durable, Ammonia-free Plastic Enclosure**
3. **Standard one-inch Mounting Centers**
4. **Easily Accessible Terminals**
5. **Polished Stainless Steel Plunger**
6. **Variety of Standard and Special Actuators**

ILLINOIS TOOL WORKS

Metal Cutting Tools, Gear Finishing and Measuring Machines and SHAKEPROOF® Fastenings

LICON

SWITCH AND CONTROL DIVISION

2501 North Keeler Avenue • Chicago 39, Illinois

New! HERMETIC LIMIT SWITCH LICON TYPE 60 Switch featuring the exclusive "WOBELLOW"* seal for true hermetic sealing. Write for information.

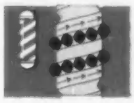
*Trade-mark

HOW MANY POSITIONING PROBLEMS CAN THESE AMAZING UNITS SOLVE FOR YOU?

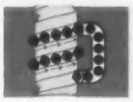
Frankly, we don't know. Almost daily we hear of some new application that never occurred to us. But we do know this: electronics engineers are achieving the "impossible" with Saginaw ball/bearing Screws and Splines, particularly these miniature sizes, from 1½ to 3 inches long.

CHECK THESE UNPRECEDENTED PERFORMANCE ADVANTAGES:

Saginaw ball/bearing SCREWS

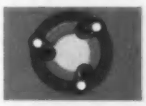


Nut *glides* on steel balls. Like stripes on a barber pole, the balls travel toward end of nut through spiral "tunnel" formed by concave threads in both screw and mating nut.

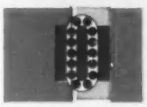


At end of trip, one or more tubular guides lead balls diagonally back across outside of nut to starting point, forming closed circuit through which balls recirculate.

Saginaw ball/bearing SPLINES



The *Saginaw b/b Spline* radically increases the efficiency of transmitting or restraining high torque loads. Instead of *sliding* against each other, the mating surfaces *glide* on rolling balls.



The steel balls recirculate in closed circuits formed by mating longitudinal raceways spaced around the circumference of both inner and outer splines. Guides return balls to starting point.

UP TO 5 TIMES MORE EFFICIENT

Up to 95% efficiency guaranteed in transforming rotary to linear motion; over 80% efficiency, linear to rotary. Require less than 1/5 as much torque as conventional Acme screws for equal output.

SAVE SPACE, WEIGHT, POWER

Permit much smaller, lighter motors and auxiliary equipment. Saginaw b/b Screws have been built from 1½ inches to 39½ feet in length.

PRECISE POSITIONING AND SYNCHRONIZING

Machine-ground types provide precision control within fractional thousandths of an inch, plus perfect synchronization of two or more movements.

OPERATE IN VERY ADVERSE ENVIRONMENTS

Saginaw b/b Screws have been designed and built to operate from −75° to +900° F. Even if lubrication fails or cannot be originally provided, they will still function with remarkable efficiency.

LONG, DEPENDABLE SERVICE LIFE

Accurately predictable life engineered to design requirements. Special Gothic arch groove design and multiple circuits assure dependable performance.

40 TIMES LOWER FRICTION COEFFICIENT THAN ORDINARY SLIDING SPLINES

By applying the same basic gliding ball principle pioneered by Saginaw in the ball/bearing screw, this revolutionary new kind of spline makes practical new engineering designs never before possible.

TRANSMIT OR RESTRAIN HIGH TORQUE LOADS FAR MORE EFFICIENTLY

In any application where column length must change under torque load, the Saginaw b/b Spline offers unprecedented freedom from sliding spline restrictions.

WIDE CHOICE OF ATTACHMENTS

Can be fitted with integral gears, clutch dogs, bearing and sprocket seats or other attachments for use with electric, hydraulic or pneumatic units.

WIDE RANGE OF SIZES AND TYPES

Saginaw b/b Splines have been designed from 3 inches to 9 feet in length, and from 3/8 to 3¾ inches in diameter. To convert push-pull to rotary motion, helical types are available with very high leads, ranging from 20:1 to 100:1.

Saginaw

ball bearing Screws & Splines

MAIL COUPON TODAY FOR NEW ENGINEERING DATA BOOK

Saginaw Steering Gear Division
Ball Bearing Screw & Spline Operation
General Motors Corporation
Dept. 41, Saginaw, Michigan
Please send your Engineering Data Book to:

Name—Title_____

Firm_____

Address_____

City_____ Zone____ State_____

1085 standard sizes

only Oilite

gives you such a wide range of self-lubricating bronze bearings ***from stock***

1085 **STANDARD SIZES** of OILITE self-lubricating bronze bearings now are available to you through your local OILITE Dealer.

Now you save set-up and tooling costs on standard OILITE bronze self-lubricating bearings. From *a total of 1085* standard sizes in OILITE bronze bearing stocks—including *315* new standard sizes—you can fill nearly all of your self-lubricating bronze bearing requirements. Faster! Economically! In any quantity!

For *non-standard sizes*, you can order ferrous and non-ferrous OILITE bearings produced from any one of 25,000 dies at our plant—for sleeve, flange, thrust and spherical bearings. There is no charge for their use; only a nominal set-up cost on quantities of less than 1000.

And for help on unusual bearing problems you can call upon the unmatched engineering skill of Chrysler-Amplex in powder metallurgy.

You'll want the new OILITE Bearing Stock List S-56 which gives the 1085 standard OILITE bronze bearing sizes and the complete list of OILITE bronze cored, bar and plate material from stock. It's free! Write us today or phone your local dealer. He is listed in the Yellow Pages of your telephone book under "Bearings—OILITE."

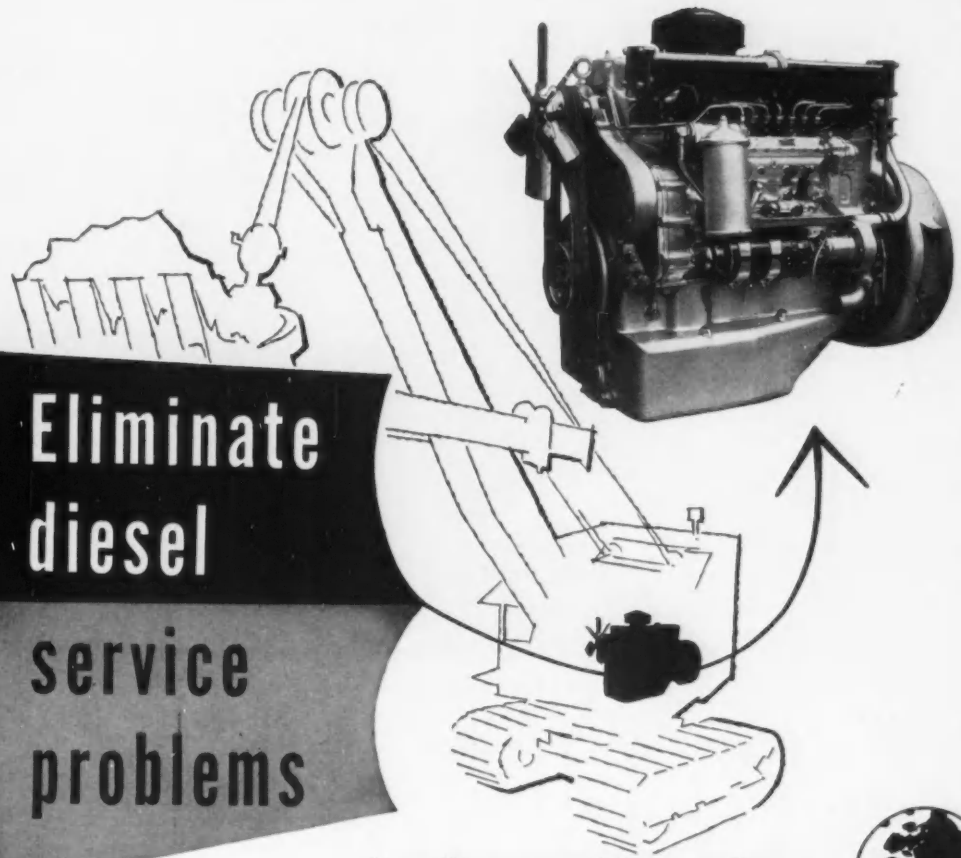
A CHRYSLER OILITE PRODUCT

ONLY CHRYSLER MAKES OILITE

AMPLEX DIVISION

CHRYSLER CORPORATION • DETROIT 31, MICHIGAN

Bearings • Finished Machine Parts • Permanent Metal Filters • Friction Units



Eliminate diesel service problems in the world market

F. PERKINS LTD. (makers of internationally famous Perkins Diesel Engines) Have Sales, Service and Parts Outlets in 106 Countries.

Perkins Diesels are in use in the following 118 countries and regions:

ADEN
AFGHANISTAN
ALGERIA
ANGOLA
ARABIA
ARGENTINA
AUSTRIA
AUSTRALIA
AZORS
BAHAMAS
BARBADOS
BELGIAN CONGO
BELGIUM
BERMUDA
BOLIVIA
BORNEO
BRAZIL
BRIT. CAMEROONS
BRIT. GUIANA
BRIT. HONDURAS
BRIT. N. BORNEO
BRIT. SOMALILAND
BURMA
CANADA
CEYLON
CHILE
CHINA
COLOMBIA
COSTA RICA
CUBA
CURACAO
CYPRUS
CZECHOSLOVAKIA
DENMARK
DOMINICA
ECUADOR
EIRE
EGYPT
FED. MALAY STATES
FINLAND
FIJI ISLES
FRANCE
FR. CAMEROONS
FR. EQUAT. AFRICA
FR. GUINEA
GERMANY
GIBRALTAR
GOLD COAST
GREECE
GUATEMALA
HAITI
HOLLAND
HUNGARY
ICELAND
INDIA
INDONESIA
ITALY
IRAQ
JAMAICA
JAPAN
KENYA
LIBERIA
LIBYA
LUXEMBOURG
MADAGASCAR
MADEIRA
MALAY
MALTA
MAURITIUS
MEXICO
MOROCCO
MOZAMBIQUE
NEW GUINEA
NEW ZEALAND
NICARAGUA
NIGERIA
NORTH RHODESIA
NORWAY
NYASALAND
PAKISTAN
PALESTINE
PANAMA
PARAGUAY
PERSIA
PERU
PHILIPPINES
POLAND
PORT. GUINEA
PORTUGAL
PUERTO RICO
RUMANIA
SALVADOR
SAUDI ARABIA
SIERRA LEONE
SINGAPORE
S. RHODESIA
S. W. AFRICA
SPAIN
SUDAN
SWAZILAND
SWEDEN
SWITZERLAND
SYRIA
TANGANYIKA
THAILAND
TRANS JORDAN
TRINIDAD
TUNISIA
TURKEY
UGANDA
UNION S. AFRICA
URUGUAY
UNITED KINGDOM
U.S.A.
U.S.S.R.
VENEZUELA
WEST AFRICA
YUGOSLAVIA

You can ship heavy export units—without motors—to almost any busy spot on earth—and rely on Perkins to install and service the power for those units at destination point!

Perkins produced over 4,000,000 brake horsepower in light, high-speed diesel engines in 1954. 70% of this output went into the world markets—where Perkins Diesels set the world standard in motors up to 120 B.H.P.

These versatile engines are available to specifications of your own engineering department. And Perkins maintain an engineering staff in Toronto, Canada to work with your company. Simply phone them. They will fly down to discuss applications with you.
Prototype installations can be made at Toronto or at your plant. Deliveries can be made from Sterling sources to you or direct to your overseas branches or distributors.

Make sure of expert diesel service and availability of engine parts for all your export units . . . cut shipping costs and assembly headaches . . . call Perkins Toronto Office today.

5507

Perkins

F. PERKINS (CANADA) LTD.
wholly owned subsidiary of
F. PERKINS LTD., PETERBOROUGH, ENGLAND

Nicholson *steam trap* quality *gives you* . . .

extra stamina for severest service

Write, today, for your copy of new Bulletin 10-55—for detailed information.

Nicholson quality . . . throughout . . . means the extra strength, extra capacity, extra stamina that never let down. And, Nicholson quality pays off, when it comes to discharging condensate and air from steam-using equipment . . . most efficiently, dependably, economically.

- **powerful valve action—big husky bellows.**
- **positive shut-off—finely ground valve and seat.**
- **high capacity—effective use of large orifice.**
- **each unit service tested—with steam.**

When less than the best won't do, specify Nicholson.

NICHOLSON

W. H. NICHOLSON and Company

TRAPS • VALVES • FLOATS • METAL PARTITIONS
LAUNDRY, DRY CLEANING AND PRESSING MACHINERY

14 OREGON STREET, WILKES-BARRE, PA. • SALES AND ENGINEERING OFFICES IN 98 PRINCIPAL CITIES

Guarantee TOP Performance and Maximum Life!

Specify THESE TOP QUALITY FEATURES...

(Standard on Miller Cylinders at no extra cost)

Specify CASE HARDENED CHROME PLATED PISTON RODS

On all Air and Hydraulic Cylinders

Benefits To You

CASE-HARDENED Piston Rods (52-54 Rockwell "C") provide practically complete protection against damage from hammer blows, wrench-dropping, mishandling, and similar occurrences. ***Available from Miller at no extra cost.***

The HARD CHROME PLATING over the case-hardened rods protects against scratch-damage and rust. ***Available from Miller at no extra cost.***

Specify "TEFLON" WIPERS

On all Air and Hydraulic Cylinders

Benefits To You

"TEFLON" Rod Wipers and "TEFLON" Hydraulic Piston Rod Seals withstand temperatures from—100°F. to plus 500°F. They are impervious to practically all known chemicals, including the fire-resistant, special, and standard hydraulic fluids in current use. ***Available from Miller at no extra cost.***

Specify TEFLON HYDRAULIC ROD SEALS

On all Hydraulic Cylinders

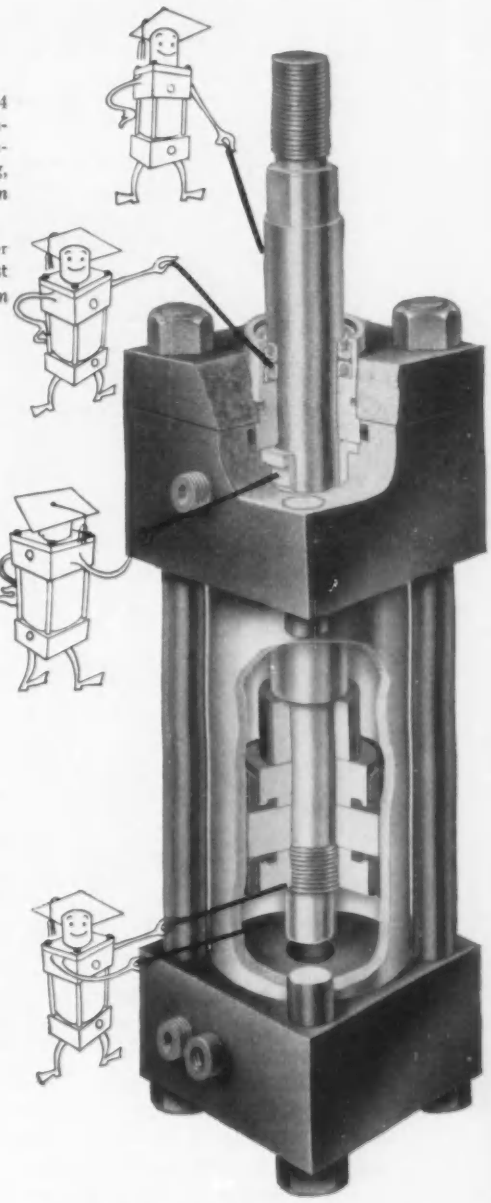
Specify RUST RESISTANT SURFACES

On all Air and Hydraulic Cylinders

Benefits To You

Highest quality Black Ferric Oxide Finish provides rust protection in air cylinder operation and on all cylinders during shipping and installation.

Cylinder heads, caps, mountings, pistons, followers, tie rods, and the unplated portions of the piston rods have this finish ***at no extra cost on all Miller cylinders.*** (This finish not recommended for water service)



NOTE. On all Miller Hydraulic Piston Seals: Leather Cup Seals are *standard*, Piston Ring Seals are optional at *no extra cost*, and "Teflon" Cup Seals are available *at extra cost.*

You may wish to route this entire page to the proper department in your company, by using this handy form. Additional copies on request. →

To (Dept.)_____

"On all our future cylinder requirements, please specify the above quality features."

Signed_____

Title_____

SALES AND SERVICE FROM COAST TO COAST

CLEVELAND • YOUNGSTOWN • DAYTON • TOLEDO • CINCINNATI • COLUMBUS
PITTSBURGH • PHILADELPHIA • BOSTON • HARTFORD • NEW YORK CITY
BUFFALO • ROCHESTER • MINNEAPOLIS • GRAND RAPIDS • DETROIT • FLINT
FORT WAYNE • SOUTH BEND • INDIANAPOLIS • MILWAUKEE • LOUISVILLE
KANSAS CITY • SEATTLE • LOS ANGELES • SAN FRANCISCO • BALTIMORE
DENVER • ST. LOUIS • MOLINE • CHICAGO • HOUSTON • ATLANTA
TORONTO, CANADA and OTHER AREAS

Miller

MILLER FLUID POWER DIVISION FLICK-REEDY CORP.

2002-04 N. Hawthorne Ave. Melrose Park, Ill.

AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS

YOUR "SPECIAL" TIMER
may be one of our
721 STANDARD UNITS!

We have 20 years of experience in developing new timers to meet our customers' widely varying requirements. Our Engineering Department not only originates new designs, but also develops modifications for that purpose. That's why most requests for special timers can be filled without delay—by one of the 721 combinations we've developed so far from our 17 basic types of timers. But if we don't have what you want on hand, we'll welcome the chance to design and make it for you! And quickly too!

We manufacture a complete line of timers in these 4 broad classifications:

INTERVAL TIMERS • TIME DELAY TIMERS
RE-CYCLING TIMERS • RUNNING TIME METERS

Our large stock assures you of rapid deliveries—even when we have to create a brand new timer for your special needs. Ask us first—you may save yourself much lost motion... and your inquiry will receive prompt attention.

Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION

1415 McCARTER HIGHWAY, NEWARK 4, N. J.

Now— FOR THE FIRST TIME EVER...

Laminated Shims of STAINLESS STEEL

Only in LAMINUM® can you get the unique qualities of *stainless steel* combined with the advantages of *surface-bonded laminated shims.*

Material is tough, corrosion-resistant Type 302 Stainless Steel (min. 95,000 psi). Laminations are either 0.002" or 0.003", and they simply p-e-e-l for time-saving adjustment to give you a "thousandth" fit right at the job. No machining. No grinding. No miking. And no dirt between layers!

Stainless Steel LAMINUM® Shims are custom-cut to any shape from any of our standard thicknesses; write for stainless steel specifications.

LAMINATED SHIM COMPANY, INC.

Send us your blueprints and quantity requirements for a quotation; there's no obligation.

SHIM HEADQUARTERS SINCE 1913

1404 UNION STREET, GLENBROOK, CONNECTICUT

DESIGN SOLUTIONS with G-E

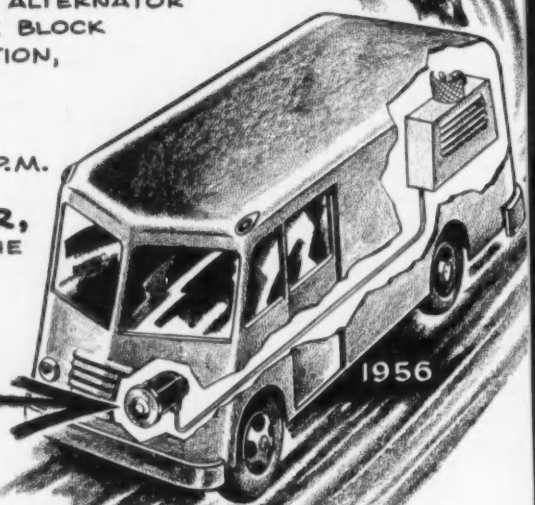
NOW SPECIAL G-E ALTERNATOR MAKES TRUCK REFRIGERATION ALL-ELECTRIC

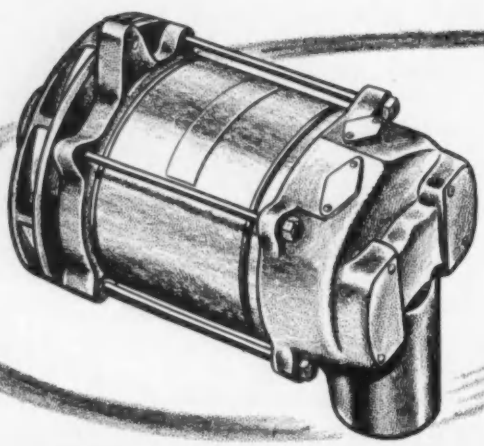
BUILT TO WITHSTAND HEAT, ROAD SHOCK, MOISTURE...

TO PROVIDE MILK AND OTHER TYPES OF DELIVERY TRUCKS WITH STAND-BY COOLING, MORE ROOM FOR PAYLOAD, DRY COLD, AND MANY OTHER BENEFITS, G.E. HAS DESIGNED A SET OF ELECTRICAL COMPONENTS THAT NOW MAKE POSSIBLE **NEW ALL-ELECTRIC TRUCK REFRIGERATION.**

THE STURDY AND WEATHER-RESISTANT G-E ALTERNATOR IS DESIGNED TO BE MOUNTED ON THE ENGINE BLOCK WHERE IT MUST WITHSTAND CONTINUOUS VIBRATION, ROAD SHOCK, DUST, HEAT FROM THE ENGINE. SPECIAL ELECTRICAL CHARACTERISTICS OF THE ALTERNATOR INCLUDE WIDE RANGE OF OPERATING SPEEDS — FROM 1500 TO 10,500 R.P.M.

A SELENIUM RECTIFIER, VOLTAGE REGULATOR, COMPRESSOR DRIVE MOTOR, EVAPORATOR FAN MOTOR — OPERATE WITH THE ALTERNATOR TO MAKE UP POWER SUPPLY FOR THIS NEW METHOD OF TRUCK REFRIGERATION.





NEW DEVICE CHECKS ON BAD CHECKS

POWERED BY EXCLUSIVE LOW-SPEED G-E A-C MOTOR

G-E SYNCHRONOUS INDUCTOR 75 R.P.M. MOTOR — EQUIPPED WITH SPECIAL OPEN-SPUR GEARING BY CUSTOMER — CAN OPERATE UNDER 10 R.P.M. PERMITS INSTANT STOPS AND STARTS ON AUTOMATIC BAD CHECK DETECTOR DEVICE. THE MOTOR OPERATES A CAMERA DRIVE — TRIPS THE SHUTTER AND WINDS FILM. MACHINE RECORDS ON A SINGLE 35 MM FRAME OF FILM A PHOTOGRAPHIC LIKENESS OF EACH CHECK AND OF THE PERSON WHO WROTE IT.

specialty motors

"LOCOMOTIVE TO YARD"

RAILROADS NOW DEPEND ON TELEPHONE COMMUNICATIONS POWERED BY G-E MOTOR ALTERNATOR

G-E MOTOR ALTERNATOR SETS FOR RAILWAY COMMUNICATIONS MUST DELIVER EXTRA—RELIABLE PERFORMANCE, AND AT THE SAME TIME STAND UP AGAINST THE ABUSE OF RAILROAD VIBRATIONS, AND ALL-WEATHER CONDITIONS. THE SPECIALLY-DESIGNED ALTERNATOR, ENCASED IN A RUGGED HOUSING, NOW PERMITS INSTANT CONTACT BETWEEN YARD AND TRAIN, OR BETWEEN LOCOMOTIVE AND CABOOSE. BOTH OPEN, AND EXTRA-STURDY TOTALLY-ENCLOSED SETS ARE AVAILABLE. EITHER SET SUPPLIES 115-VOLT, 60 CYCLE CURRENT TO RADIO-TELEPHONE EQUIPMENT, PROVIDING SUITABLE POWER FOR A SINGLE RECEIVER, AND ONE 10-TO 30-WATT TRANSMITTER. A SPECIAL FEATURE, A BUILT-IN THERMAL OVERLOAD DEVICE, PROTECTS AGAINST EXTERNAL LINE FAILURES.

AVAILABLE: COMPLETE FHP MOTOR ENGINEERING ASSISTANCE FOR YOU!

HERE'S THE SPECIAL ATTENTION YOUR SMALL MOTOR PROBLEMS GET AT G.E.

1 YOUR LOCAL G-E APPARATUS SALES ENGINEER LEARNS ALL ABOUT YOUR MOTOR NEEDS

2 HE CALLS A TEAM OF FACTORY ENGINEERS WITH YEARS OF MOTOR APPLICATION EXPERIENCE

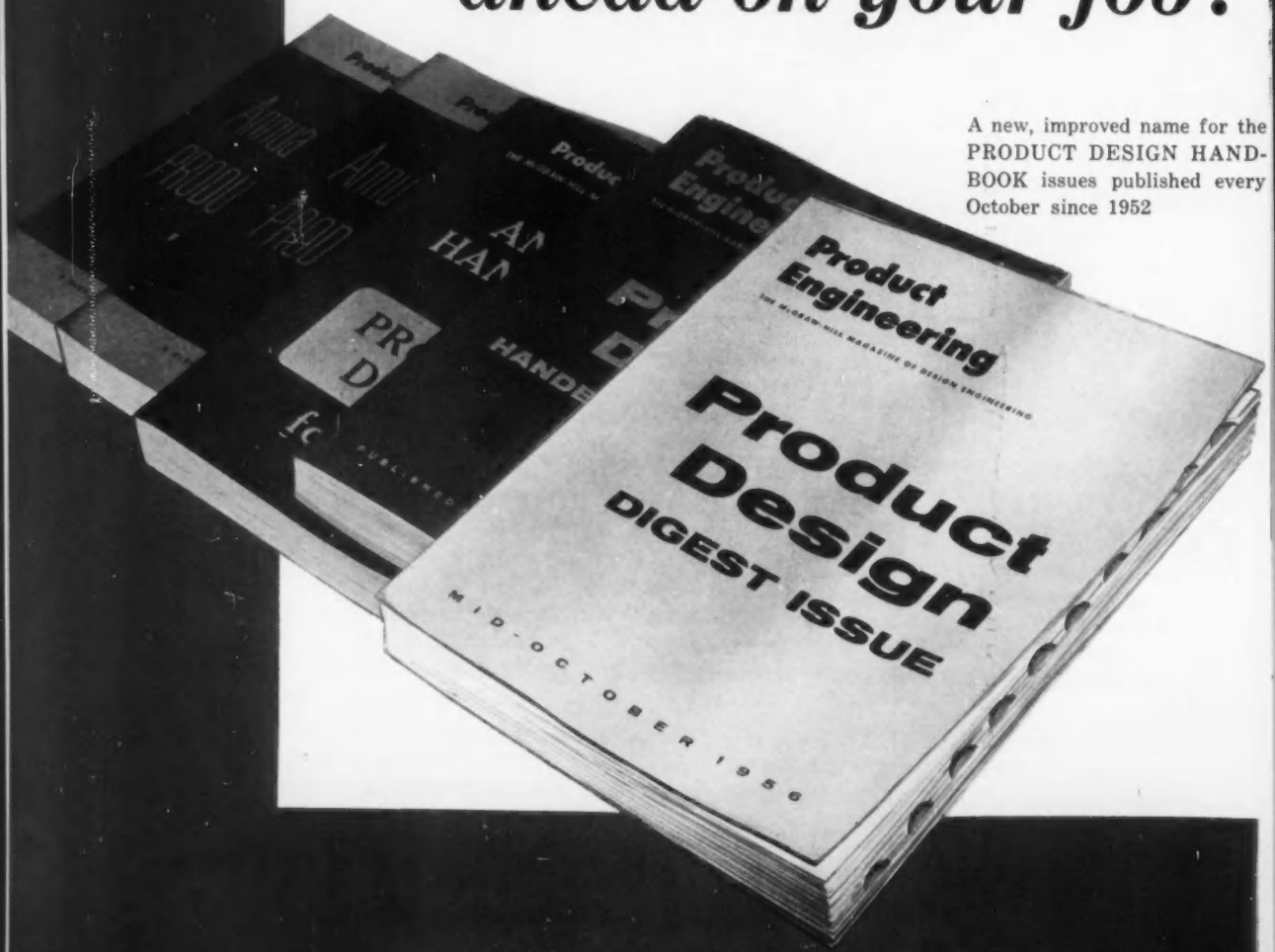
3 AT THEIR DISPOSAL ARE G.E.'S COMPLETE DEVELOPMENT AND TESTING FACILITIES

4 IN SHORT ORDER A SAMPLE G-E MOTOR IS READY FOR TESTING ON YOUR PRODUCTS

FOR THIS COMPLETE HELP, CONTACT YOUR NEARBY G-E APPARATUS SALES OFFICE, TODAY. WRITE FOR FREE BULLETINS COVERING G-E EQUIPMENT DESCRIBED IN THIS AD TO GENERAL ELECTRIC CO., SECT. 634-6, SCHENECTADY 5, N.Y.

GENERAL ELECTRIC

How the PRODUCT DESIGN DIGEST issues help you to get ahead on your job!



A new, improved name for the PRODUCT DESIGN HANDBOOK issues published every October since 1952

THE DIGEST ISSUE SAVES YOU VALUABLE TIME. For example, our editors spend the equivalent of 481 working days reviewing thousands of articles. In fact, we have a separate, full-time, year-around editorial staff which is exclusively employed to make this issue the most thorough annual DIGEST of significant developments in the field of product-design engineering.

The DIGEST gives you in a single, convenient, thumb-indexed volume NEW IDEAS and ENGINEERING DATA that you cannot find readily available from any other source. It is culled from hundreds of sources: engineering society reports and technical journals, McGraw-Hill and Non-McGraw-Hill publications, original contributions, and many sources exclusive to McGraw-Hill. In all, our editors screened over 21,000 articles.

This new, greatly improved DIGEST issue to be published in mid-October 1956 will be sent to all subscribers as part of their subscription to *Product Engineering*.

Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN ENGINEERING

McGRAW-HILL BUILDING, NEW YORK 36, N.Y.

JUST TRY IT!

..ask for a sample bar of La Salle's revolutionary

NEW fatigue-proof STEEL BAR

..the bar that has HIGH STRENGTH without heat treating

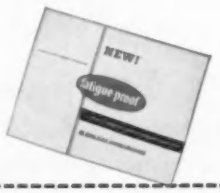
Yes, La Salle invites you to test a sample bar of the remarkable new FATIGUE-PROOF. This amazing new material is its own best recommendation . . . as proven by the many original equipment manufacturers who have already tested (and are using) FATIGUE-PROOF.

If you are making parts requiring strengths in the tensile range of 140,000 to 150,000 psi, and want to eliminate the expense or problems of heat treating . . . if you want to save production costs with a bar that machines faster (25% faster than annealed alloys—50% to 100% faster than heat treated alloys) and gives you a beautiful finish, too . . . if you want to improve the quality of your product while saving money, send us a blueprint, drop us a note giving application details, or better yet . . . pick up your telephone and call a La Salle sales engineer (REgent 4-7800, Chicago, Illinois).

If it appears that FATIGUE-PROOF can help you improve your product and cut your cost, he will arrange to provide the necessary test sample at no expense to you.

NEWLY PUBLISHED!

Get your copy of this 20-page booklet which gives detailed information on the remarkable new "FATIGUE-PROOF."



La Salle STEEL CO.
1430 150th STREET • HAMMOND, INDIANA
Manufacturers of America's Most Complete Line of Quality Cold-Finished Steel Bars

Please send me your "FATIGUE-PROOF" Bulletin.

Name_____

Title_____

Company_____

Address_____

City_____ Zone_____ State_____

Perspectives

IN DESIGN AND DEVELOPMENT

CONSENT DECREES AND PATENTS

With the smoke settled around the consent decree involving the American Telephone & Telegraph Company (AT&T), and Western Electric Co., Inc., the feeling is that AT&T did not lose much after 7 years of litigation. Under the terms of the decree, AT&T and its manufacturing subsidiary Western Electric, must make available to all comers, on a royalty-free basis, all of its patents issued up to the day of the court's decision. This amounts to about 8600 patents, and the "royalty-free" requirement lops off about $5- to 6-million of AT&T's annual income.

All patents issued to AT&T after the date of the consent decree must be made available on a reasonable royalty basis—which will be decided by the court if the two parties cannot come to an agreement. (AT&T, through its research branch, Bell Telephone Labs., gets from 400 to 500 patents each year.) This "compulsory" licensing actually is not much of a requirement, for AT&T has been granting such licenses for years. The most recent count was 1100 licenses with about 800 different companies.

One stipulation on this last point is that if a company seeking a license from AT&T on a royalty basis has a patent which AT&T wants to license, the other company must offer the use of any of its patents covering the "common carrier communications equipment and related machines, tools, and materials," or AT&T can refuse to grant the company a license.

SUIT FILED SEVEN YEARS AGO

The government originally filed the antitrust suit back in 1949, demanding that AT&T divest itself of Western Electric, and, that Western Electric should be split into three separate companies. The two companies had been charged with violating the Sherman Act in the manufacture, distribution, and sale of phones and allied equipment. The government also demanded that Western Electric sell its 50 per cent interest in Bell Labs. to AT&T, and that AT&T relinquish much of its control over its 21 operating companies.

GOVERNMENT GIVES UP

Somewhere along the line, AT&T convinced the government that giving up Western would necessitate an increase in costs for equipment and services to the Bell System companies. AT&T maintained that it would be impossible to get elsewhere the high quality of production possible with Western. AT&T by way of throwing something to the wolves, preferred to part with its patents rather than give up its manufacturing subsidiary. But even if this tends to show AT&T as a monopoly, the company is so strictly regulated by the Federal Communications Commission and each state board that such a monopoly will not mean much.

AT&T WAS ABLE TO GET OUT

The point that is not made clear, however, is that if the government agreed that the splitting off of Western Electric was bad for AT&T, why wasn't the case simply dropped? The story is that the government offered

(Continued on page 131)

what can you expect to pay for custom-molded plastic parts at CHICAGO MOLDED?

Chicago Molded publishes a data-packed magazine called *Plastics Progress* to keep you up-to-date on many of the latest developments in plastics. You can get a *free subscription* by filling out the coupon below! Better do it now.

CHICAGO MOLDED PRODUCTS CORP.

1032 North Kolmar Avenue
Chicago 51, Illinois

Please add my name to your mailing list for a *free* subscription to *Plastics Progress*.

Name_____

Company_____

Address_____

_____

You'll pay no more—often much less—for plastic parts at Chicago Molded. Here's why . . .

CMPC engineers and designers know how to produce the part you need in the most economical way . . . consistent with quality. You *never* get suggestions that result in a poorer product! You *do* get advice based on sound practice . . . modern methods . . . and 37 years experience in molding every type of plastic material.

Chicago Molded's unbeatable facilities include the world's foremost mold engineering facilities, as well as every type and size of press – automatic, semi-automatic, double-ram, and thermoplastic injection. With these, CMPC produces anything from the smallest to the largest plastic parts – quickly, economically, and in any quantity.

CMPC "follow-up" service means continuing savings for you. Our engineers keep in touch with your operations, help eliminate costly, unnecessary frills . . . suggest better molding materials . . . even help develop whole new processes to make your product better, more saleable, lower priced. *Now you know why 60% of our business comes from firms we've served for 15 years or more!*

to do this, but AT&T preferred to have some type of judgment rendered against it with the thought that the antitrust division would not come back with a similar charge (divestiture of Western Electric) at a later date. Such a consent decree, as was finally reached, does not constitute an admission of guilt on AT&T's part; but neither does it prevent the government from levying the same charge all over again.

EFFECT ON PATENT SYSTEM

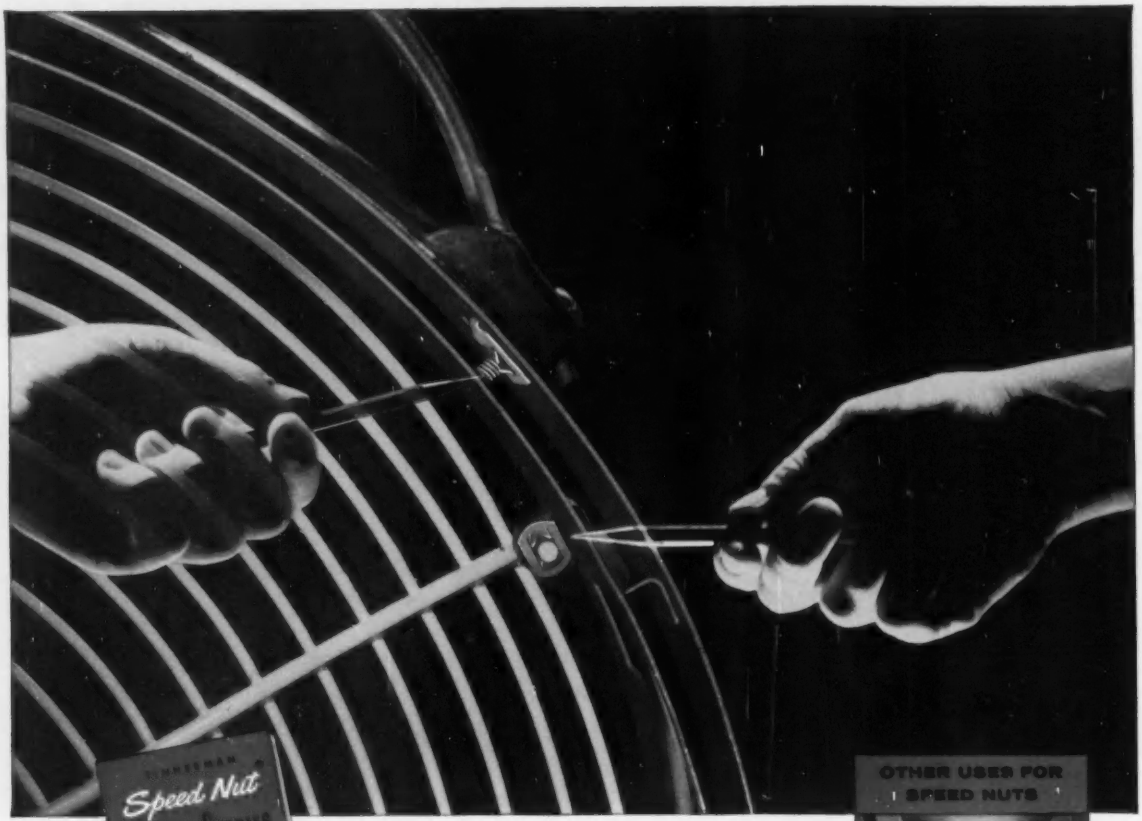
But what will this historic decision mean to the entire patent system? What will be its effect on the research and development picture? Could it, for example, set the precedent for future compulsory patent licensing provisions, with companies being forced to share their technical knowledge and know-how with others? This is not what the patent system was designed to do. The inventor was given 17 years of protection from infringement of others if he revealed his invention to the public. This, theoretically, would give him the opportunity to go into business to manufacture and sell his product, and by so doing repay him for the time, energy, and money devoted to his research on that product.

Several research organizations and heads of research of large companies feel that insofar as the patent system is concerned, the consent decree was not a good decision. But they add that a patent today is not as valuable as it was years ago, particularly in the electronics field. Companies are not interested so much in the patent protection or the control of a new product or development as much as they are interested in getting a two or three year time advantage over their competitor. Their prime concern is to stay ahead of the game and to gain the slight time advantage necessary to perfect and get the product on the market, and make a profit. Basic patents are hard to come by in the electronics field. Nowadays it is virtually impossible for a patent to run the full 17 year course of protection as it did in the past. There is always something to supersede it. For example, it is highly possible that something will be developed soon to replace the transistor. With more than $5-billion invested in research and development, it is almost a certainty.

HOW ABOUT RESEARCH AND DEVELOPMENT

As to the effect on the research development picture, the most dire prediction was that it would be somewhat inhibited. It could lead to a situation where just the basic research would be done at research institutes and colleges, while the development, or the applied work would be done only at the companies. The point here being that companies would keep much of its work secret, and not reveal its work to the Patent Office for fear of having no patent protection.

Another viewpoint is that the research and development programs are regarded as so important that things of this sort (the consent judgement) will be taken in stride and the various companies will accommodate their operations to the situation as it exists. The patent system has always implied a degree of secrecy over a period of time, and if this is in any way reduced by the operation of this decree or subsequent rulings, then the research and development activities will be at an increased pace.



37% cost saving in production, 28% saving on assembly with Tinnerman SPEED NUTS®!

It takes only 5 Tinnerman SPEED NUTS to cut costs on the Atlas-Aire Utility Fan, manufactured by the Atlas Tool and Manufacturing Company, St. Louis.

Two "J" Type SPEED NUTS make a lightning-fast, vibrationproof attachment of carrying handle to fan housing. Three Push-On SPEED NUTS firmly secure the grill to the housing.

Twelve parts were eliminated to bring about a 37% cost saving; total assembly time has been reduced from 25 to 18 minutes to effect a 28% time saving. The elimination of a spot welding operation and a punch press also resulted in a better use of over 400 square feet of floor space!

Your Tinnerman representative can offer you over 8,000 different shapes and sizes of SPEED NUT brand fasteners to produce similar fastening savings in your product assemblies. Call him, or write for your free copy of "SPEED NUT Savings Stories."

TINNERMAN PRODUCTS, INC. • BOX 6688, DEPT. 12, CLEVELAND 1, OHIO
Canada: Dominion Fasteners, Limited, Hamilton, Ontario. *Great Britain:* Simmonds Aerocessories, Limited, Treforest, Wales. *France:* Aerocessoires Simmonds, S. A., 7 rue Henri Barbusse, Levallois (Seine). *Germany:* Hans Sickinger GmbH "MECANO", Lemgo-i-Lippe.

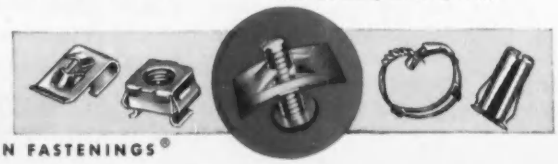
OTHER USES FOR SPEED NUTS

Jet-convector heater manufacturer uses "U" and "J" type SPEED NUTS, reduces assembly time by 50%.

"U" and "J" type SPEED NUTS designed into new gas range gain 50% assembly time saving.

On this ceiling light, special SPEED NUT replaces 3 parts, cuts assembly time by 80%!

TINNERMAN
Speed Nuts
FASTEST THING IN FASTENINGS®



How Much for Research?

WHAT IS A REASONABLE AMOUNT OF MONEY TO SPEND ON RESEARCH? Usually the answer is requested to be in terms of per cent of gross sales, per cent of net profit, or some similar basis. But in the final analysis it is impossible to give a definite answer to this question.

The famous slogan of the General Electric Company, "Progress is Our Most Important Product," points to some possible answers to the question, "How much shall we spend for research?" No one can intelligently dispute the factual truth of the General Electric slogan. Only the company that keeps up with progress can prosper. Therein lies the answer to that vexing question: How much shall we spend for research?

In the medical field there is no limit to the amount of money that should be spent on research. There is no dollar sign on the value of a human life or the price to pay for freedom from suffering. But in the world of material progress the yardstick is different. Profits go to the company that is in the forefront of progress as measured by its position relative to that of its competitors.

A small struggling company might spend a few thousands to develop a new automatic operation, or a machine that will outproduce all existing ones, or a control system that is truly fantastic. In achieving the objective, the little struggling company establishes itself as the first in its field and thereby earns a reputation that usually brings in a flood of business that results in profits far greater than expected.

Admittedly, waste and ignorance can easily pyramid the costs of research. Stupidity can result in wrong research answers. A domineering management might insist on unsound or even futile research and development programs. Under such conditions the finest research department under the most able direction can produce little or nothing. But, assuming a businesslike efficiently operated research department, it should have at its disposal a budget big enough to assure an amount of progress that will keep the company abreast of, or preferably ahead of, its competition. That is the only basis for the answer to the question: How much for research?

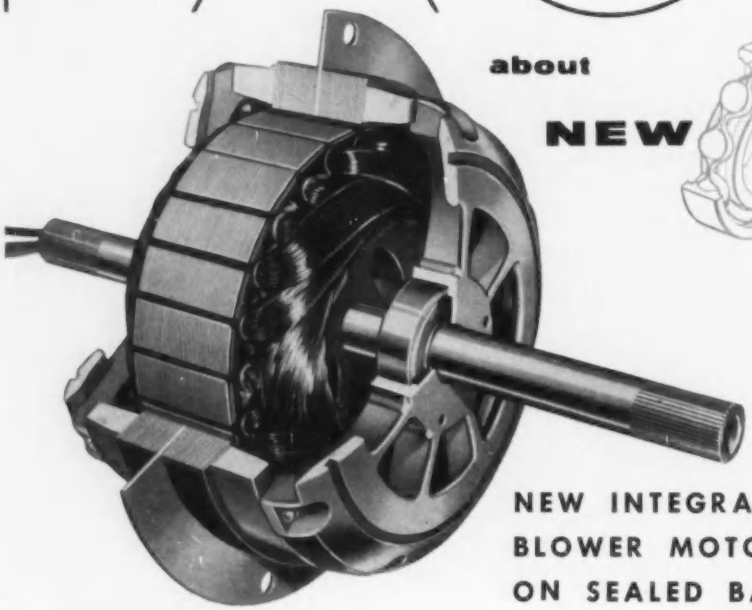
George F. Rockwell

FACTS

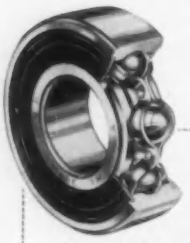
about

NEW DEPARTURE

BALL BEARINGS



NEW INTEGRAL-DRIVE BLOWER MOTOR DEPENDS ON SEALED BALL BEARINGS!



5 advantages of New Departure's Sentri-Seal ball bearings in electric motor applications

- **SEALED AND LUBRICATED FOR LIFE!** No need for relubrication; no danger of over- or under-lubrication.
- **SIMPLIFY DESIGN!** Eliminate need for separate seals and grease fittings.
- **CARRY LOADS IN ANY POSITION!** Moving parts are held in positive alignment, regardless of motor mounting position.
- **WEAR IS NEGLIGIBLE!** Require no attention for adjustment for wear. Have a reputation for outlasting the products they serve.
- **QUIET-RUNNING!** New Departure ball bearings are precision-made, run smoothly. Their uniformity is a guarantee of dependability.

Nowhere is the superiority of New Departure sealed ball bearings in electric motor applications better exemplified than in this new integral-drive blower motor.

Revolutionary "inside-out" design of this new motor imposed a lubrication problem solved by the permanent-lubrication characteristic of the finest sealed ball bearings. In this motor, the rotating element, to which the blower wheel is attached, is on the outside and revolves around a stationary shaft through which the lead wires pass. "Sealed and lubricated-for-life" New Departure ball bearings were selected because they assure permanent lubrication, regardless of centrifugal force. Also, because motor and blower wheel share the same permanently lubricated bearings, this integral unit is free of the need for periodic servicing.

Equally important, New Departure sealed ball bearings handle combination loads in any position . . . assure positive alignment of rotor and stator. This means a versatility of application for this motor that offers new freedom to designers.

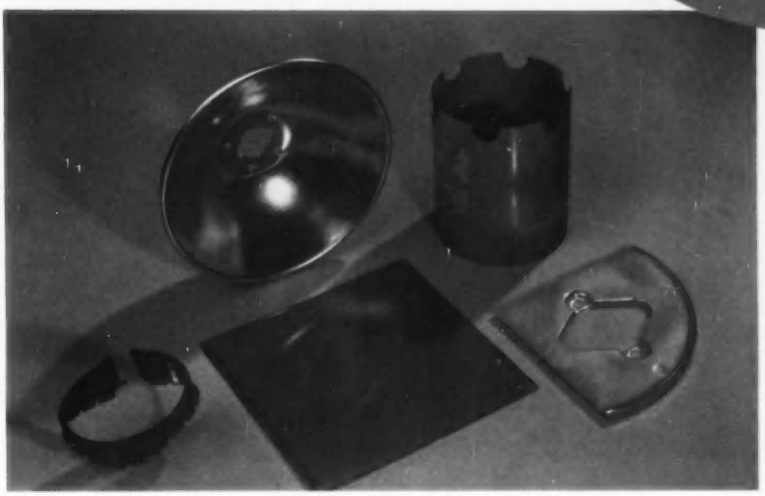
Sealed ball bearings also help increase motor efficiency and reduce electrical hum. Since in ball bearings wear is so slight as to be entirely negligible, designers were able to build in a smaller precision air gap, which is maintained throughout motor life.

Let New Departure's unexcelled engineering service show you the many advantages of sealed ball bearings in electric motor and other applications.

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN.

Prefinished Aluminum

R. V. VANDENBERG
Head, Finishes Section, Process Development Lab.
Aluminum Company of America



Common articles, above, produced in aluminum and colored by the electrochemical Alumilite process; parts are first given an anodic oxide coating, and then dyed and sealed.

Left, functional use of color coatings: photoflash reflector with high spectral reflectivity; cylindrical valve sleeve is red for quick identification; non-reflective coating for goggle frame. For wall tile and clock frame, electrochemical finish is both durable and low in cost.

How electro chemical, paint and electroplated coatings withstand forming operations; specific limitations for each method; types of mill products available in prefinished chemical colors.

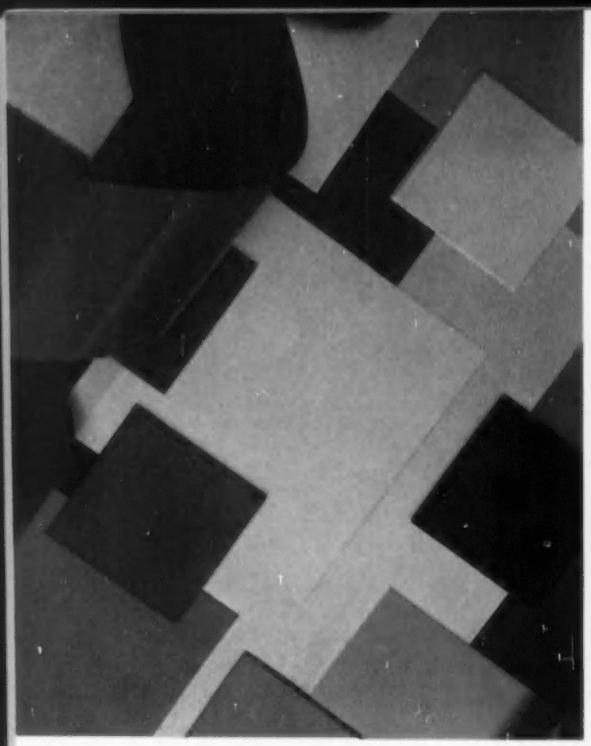
NEW FINISHING SYSTEMS and forming techniques for aluminum make it possible to fabricate parts from prefinished material with advantages in both cost and quality. These methods include electrochemical coatings, paint and electroplating, and are being applied to a variety of aluminum parts. Colored Alumilite coatings, for example, are being used for refrigerator trim, dials, weatherstrip, radiator grills, lamp reflectors, name plates, slide fasteners, goggles, buttons, tags, containers, and addressograph plates and are being considered for other automotive products.

Electrochemical Coatings

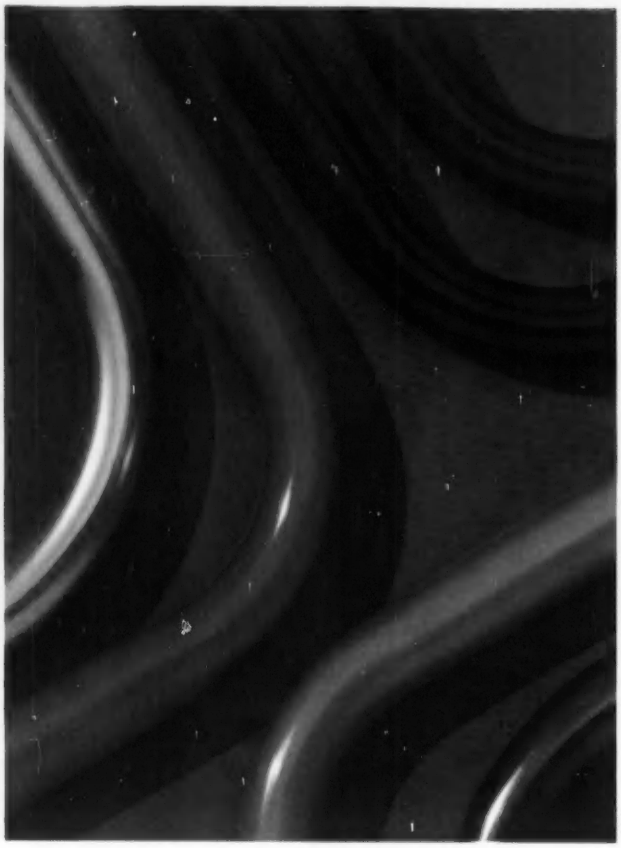
Alumilite process, often used in finishing such products, forms a surface coating of aluminum oxide by anodic oxidation of the aluminum in certain electrolytes. The process differs from electroplating; the aluminum part to be finished is made the anode rather than the cathode. Anodic treatment deposits oxygen which combines with the aluminum to form an integral coating of aluminum oxide. This adherent coating it hard, brittle and has excellent resistance to wear and abrasion.

These coatings are both protective and decorative. By controlling the processes, the properties of the coating can be varied. The coating conforms to the texture from which it is formed, and by varying the preparatory surface treatments, a wide variation in appearance is possible.

Color of the anodic coating is strongly influenced by the aluminum alloy from which it is formed. Appearance ranges from a clear, transparent finish on high purity alloys to a translucent or opaque finish, depending upon constituents or impurities in the alloy.



Standard colors supplied on aluminum mill stock in three types of electrochemical finishes; degree of forming, wear resistance and weather exposure determine the type to use.



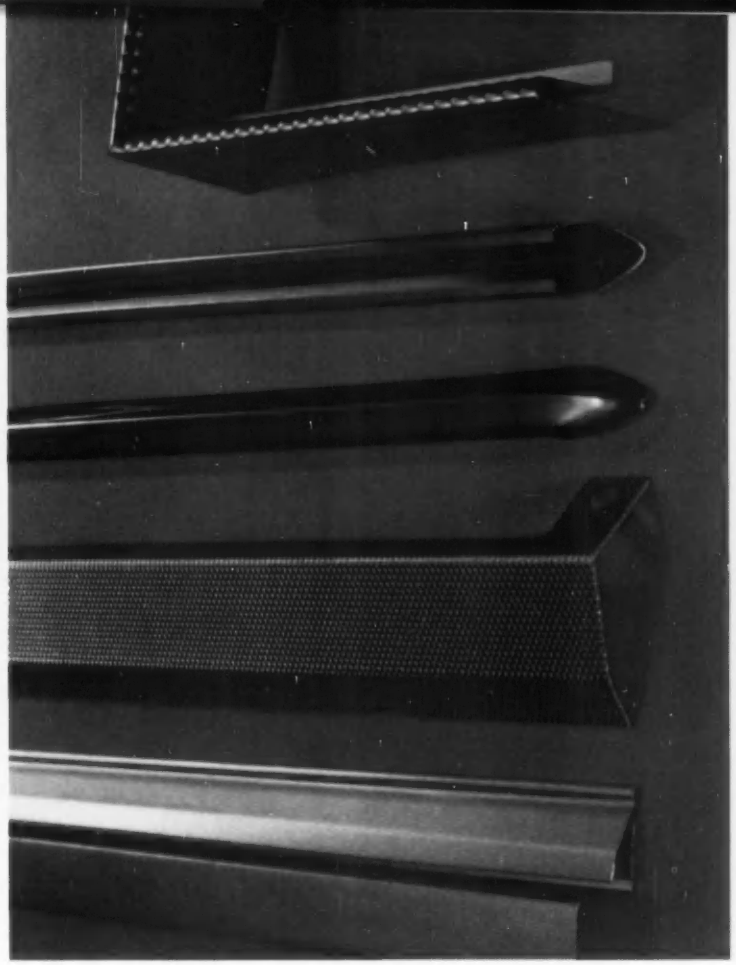
With the same range of colors and finishes, tubing has the added option of surface preparation—etching, buffing or belt polishing — prior to electrochemical finishing.

Aluminum sheet, tubing and extrusions now available in color

RED, BLUE, GREEN, GOLD and naturally metallic finishes can now be ordered on sheet, extruded shapes, rod, bar and on drawn and extruded tubing. Available types of surface preparation include etching, electrolytic brightening, buffing and belt polishing. Buffing and belt polishing can be applied only to tubing; both etched and buffed surface preparations can also be combined with electrolytic brightening. These surfaces are then oxidized by anodic treatment, colored by dyes or pigments and sealed.

Three types of finish are available depending on forming requirements and service conditions; properties and limitations of each are shown in the table. Maximum stock lengths are 30 ft for rod, bar and tubing, drawn or extruded. Coiled sheet is supplied in widths up to 24 in., from 0.006 to 0.051 in. thickness; flat sheet in all thicknesses, in widths up to 84 in. and lengths up to 32 ft. Alloys include type 1, 3003 and 6063; with the same surface preparation colors are brightest on 6063 alloy.

Finish Designation	Forming Properties	Resistance to Wear	Weather Resistance	Limitations
B2	Fair	Poor	Poor	not recommended for long outdoor use
C5	Good	Fair	Fair	limited outdoor use
F2	Poor	Good	Good	requires occasional cleaning for outdoor use



Typical parts roll formed from flat or embossed colored aluminum sheet; from top down, clock frame, molding with finished ends, radio cabinet trim and weatherstripping.

The coating is porous as formed which permits coloring the coating for decorative effects and sealing it for increased resistance to corrosion. The porosity of the oxide coating may be controlled; if extreme resistance to abrasion or corrosion is required, a dense, relatively non-porous structure can be produced. If a soft, flexible coating is required, electrolyte conditions are varied to produce porous coatings. Thickness is also easily controlled.

For a part formed from a prefinished material, porosity and thickness are important factors in specifying the coating. For example, parts that require thick, dense coatings for protection against extreme abrasion and erosion will crack when deformed. Stress at the cracks will cause fracture under further deformation, although the coating will not flake or peel. Thin, dense coatings will withstand forming without damage to the finish providing the sheet is not too thin. A more porous coating can be obtained in which the cracks that form on bending are not readily apparent. This type can be used where some bending or mild forming is required during fabrication.

These oxide coatings on aluminum are highly resistant to abrasion. The coating has the same structure as alumina, corundum and emery. Therefore, the forming operation on a part with an oxide coating will cause abrasion of most tool steels. While the finish will not cause excessive wear in most roll forming or bending operations, deep drawing operations cannot be performed successfully.

Shallow draws involving a 20 to 30 per cent reduction are possible if performed in a single operation. Rubber forming or hydraulic methods give best results, but for conditions near these limiting ranges tests should be made on existing tooling using the prefinished material.

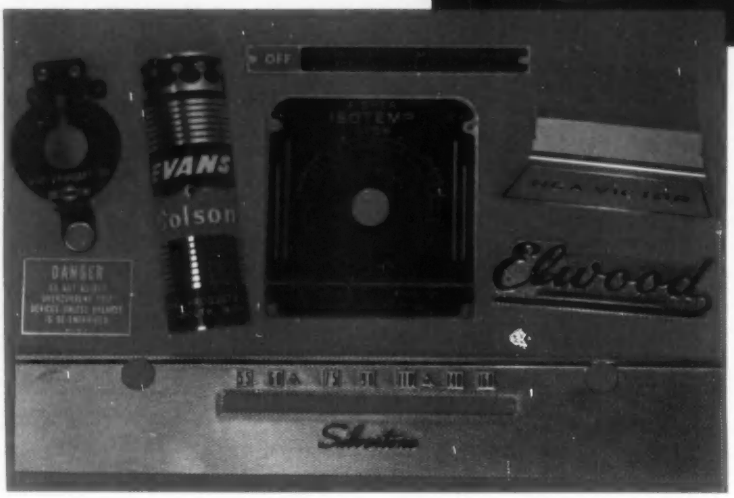
For parts exposed to weather the coating is resistant to abrasion and corrosion. When sealed with wax the surface has a low coefficient of friction and does not mark or smudge cloth, wood or painted surfaces. In manufacturing a product such as weatherstrip, sheets in widths of 6 or 12 in. and thicknesses from 0.008 to 0.020 in. are given the finish in a continuous process, after which the strips are slit to finished widths and roll-formed. The same method is also used for venetian blind slats, addressograph plates and food cans. Prefinished aluminum sheet is also used for aluminum trough type reflectors with either specular or diffuse finish; an electrobrightening treatment is used first, followed by the oxide coating, giving a surface with high reflectivity and permanence. In forming reflectors, flat sheet blanks are protected by a strippable lacquer coating to prevent scratching the reflecting surface or causing excessive abrasion of forming dies. Strippable adhesive-backed papers are also used to protect prefinished sheets during bending and assembly. But deep drawing or spinning operations will cause the coating to crack.

Alumilite coated aluminum sheet finished in various colors is used commercially for such products as buttons, dials, escutcheons, tags, fancy packaging containers and even aluminum coins. Some products – for example, goggle parts – are finished with a black coating and certain sections are then flanged by bending to the required angle.

Aluminum wire with a colored finish is formed into slide fasteners. In addition to the attractive appearance, the finish provides a wear resistant surface with low rubbing friction. Aluminum tubing with plain or colored coatings can be formed into many common articles.

Paint Coatings

Paint, lacquer or enamel can also be used as coatings on prefinished aluminum sheet fabricated into bottle seals, caps and shallow containers. Methods of application are similar to



Printed or dyed Alumilite coatings produce attractive dials, nameplates, bezels and instruction plates. Nameplates embossed from colored sheet offer opportunities for painted or filled color areas; colored textured sheet (Elwood and Silvertone, below) can be embossed flat for paint. For color on sheared edges (Collins and RCA) coating must be applied after fabricating

those used for other metals. If an enamel or lacquer finish is to be used solely for decorative purposes, the only preliminary treatment necessary is thorough cleaning with a solvent to assure a surface free from oil or grease. When the product is to be used under severe service conditions the surface must be prepared with greater care. The aluminum surface must first be treated with a phosphoric acid solution, or a chemical conversion or anodic coating should be applied.

Where maximum protection is needed primers are generally used. Standard printing or roller coating methods are used for the application of the lacquer or enamel to the sheet; decorative designs and lettering may be used. Sheets with the finish applied are fed into presses which shear and form the blank into the desired shape. For forming applications, special alkyd-resin paints are used to obtain maximum adhesion and flexibility. For preliminary surface treatments phosphoric acid "wash primers" are employed. Aluminum siding and awning parts are roll formed from coiled sheet which has been roller-coated with a lacquer or enamel and baked.

Electroplated Coatings

Aluminum sheet can be prefinished by electroplating using two different processes: anodic oxidation in oxalic or phosphoric acid electrolyte, or deposition of a zinc film on the surface by chemical replacement. Both procedures produce satisfactory adhesion, but the "zinc immersion" process is used to a greater extent because of simplicity of equipment and procedure.

Bright chromium plating over an anodic base is also available as a prefinished coating for aluminum sheet. This material is formed into such parts as deep fryer covers and decorative moldings for household appliances. Limitations on forming preplated aluminum sheet are the same as for other preplated sheet metals. If the forming is too severe, an orange peel effect will cause loss of brightness in the plated surface.

Copper-plated aluminum strip can also be formed. A zinc immersion treatment is first applied and then copper plated by a continuous process. This coating withstands the roll forming operation which corrugates and bends strip into cable sheathing; the lap joint is then sealed by soft soldering.

Background— Earlier developments in prefinishing aluminum, leading up to the availability of mill products in color as described in this article, have been presented in the following articles.

"Finishes for Aluminum Products," (by the current author) in October 1951 page 179; specifications, pretreatment, and application of mechanical, chemical, electrochemical and organic finishes.

"Mechanical Properties of Aluminum Hard Coatings," September 1954 page 136; effect of heavy oxide films on fatigue, tensile and compressive strength, corrosion and abrasion resistance.

"Nickel-Plated Aluminum Sheet," December 1954 page 167; report of tests on 3S and 24S-T4 sheet with phosphoric anodic treatment and chloride-sulphate nickel plate; effect on strength, endurance, corrosion resistance and forming operations.

"Nickel and Chromium Electroplates for Aluminum," Annual Handbook for 1955 page C2; summary of work done at Navy Bureau of Aeronautics on influence of treatment on strength and fatigue of base metal, as well as wear and corrosion resistance.

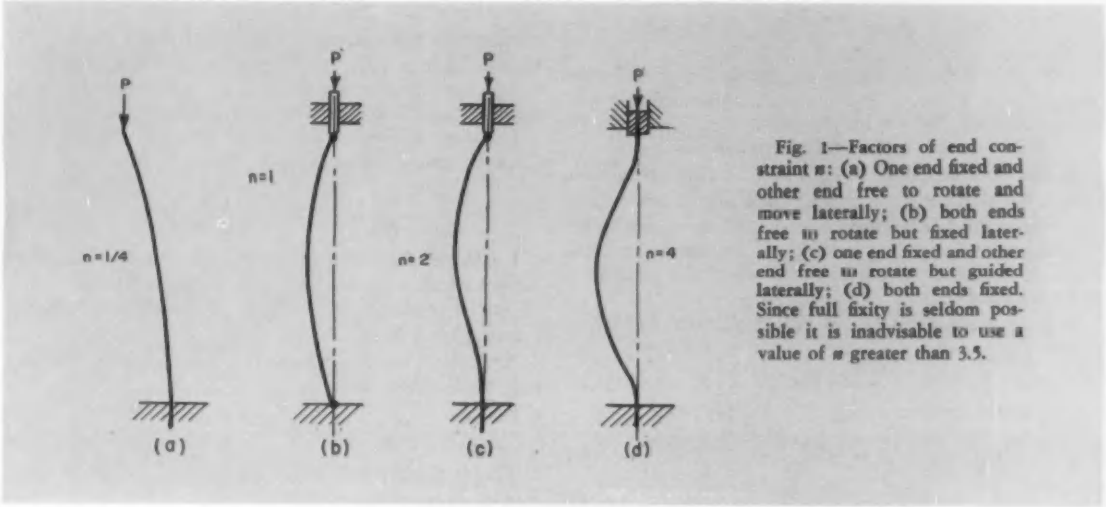


Fig. 1—Factors of end constraint n: (a) One end fixed and other end free to rotate and move laterally; (b) both ends free to rotate but fixed laterally; (c) one end fixed and other end free to rotate but guided laterally; (d) both ends fixed. Since full fixity is seldom possible it is inadvisable to use a value of n greater than 3.5.

Column Formulas— Four Basic Types

Comparision of formulas by mathematical characteristics; chart showing combinations of formulas to use for different fields of applications; variations in permissible loading with choice of formula.

GLEN H. HOWELL
Professor of Mechanical Engineering
Wayne University, Detroit, Michigan

MANY COLUMN FORMULAS have been proposed over the years. Some are founded on theory, some on experimental data, and some empirically to meet a particular combination of conditions. The range of usefulness of each formula is defined only by the slenderness ratio L/r and, because of much overlapping, confusion arises as to choice of formula for a particular application.

A clearer picture can be obtained by grouping the formulas under four major classifications: Euler, Parabolic, Straight-line, Rankine, and plotting the formulas on one master chart. Thus, the mathematical characteristics of each formula, its relative position with other formulas, and its effect on allowable or critical loads can be visually shown and defined.

Euler's Formula

Euler's formula is one of the oldest and best known of the column formulas. It is frequently written in the form

SYMBOLS

- A = cross sectional area of column, in.^{2}
- c = distance from neutral axis to extreme fiber, in.
- E = Young's modulus of elasticity, lb/in.^{2}
- I = moment of inertia of cross section with axis through neutral axis, in.^{4}
- L = length of column between lateral supports, in.
- M = bending moment, in.-lb
- P_a = allowable load on column acting through neutral axis and based on a working stress, lb.
- P_c = maximum (critical) load acting through neutral axis that column can carry without buckling, lb.
- r = radius of gyration, in.
- S_c = critical stress, lb/in.^{2}
- S_y = stress at yield point, lb/in.^{2}
- $\frac{L}{r}$ = slenderness ratio

Column = axially loaded compression member with length at least eight times the shortest dimension of its cross section.

$$P_e = \frac{n \pi^2 E I}{L^2} \quad (1)$$

where n is a factor depending on the degree of end constrainment, as shown in Fig. 1, and P_e is the load that will cause buckling. Where an allowable load is desired, P_e is divided by an applicable safety factor.

It can be seen from Eq (1) that, for columns with cross sections other than circular, buckling occurs in the direction where I is minimum—except where n also varies with the direction being considered. In the latter case, buckling will occur in the direction where the product n and I is a minimum.

A more useful form of Eq (1) is obtained by noting that

$$r = \sqrt{I/A}$$

Eq (1) then becomes:

$$\frac{P_e}{A} = \frac{n \pi^2 E}{(L/r)^2} \quad (2)$$

Compression members fail as a result of two simultaneous actions producing a maximum stress—partially by direct compressive action and partially from lateral buckling produced by a moment load. This can be stated as:

$$S_{max} = \frac{P}{A} + \frac{Mc}{I} \quad (3)$$

Eq (2) is based on the assumption that the direct stress P/A is insignificant and therefore can be neglected. This rules out the use of Eq (2) where direct stress is of importance, as in short columns.

Examination of Euler's formula plotted in Fig. 2 reveals that for small L/r ratios the load that is predicted to cause failure is inordinately high. The curve should not be used where stress exceeds S_y the yield point of the material (the ordinate in Fig. 2 can be either P_e or S_e since $A = 1$ in.^{2}). Therefore, for the conditions in Fig. 2, Euler's equation is not valid for L/r values less than 80. Most references arbitrarily say that Euler's formula should be used for values of $L/r > 150$ since, in this region, results agree with experimental data. A more rational approach is to use Euler's formula up to the intersection of the Euler curve with either the straight-line or parabolic curve.

Parabolic Formulas

Parabolic column formulas derive their name from the parabola that results when loads are plotted against L/r ratios. They can be divided into two groups: one type which defines a critical or failing load—such as the J. B. Johnson formula; and the second type which incorporates both a safety factor and an n factor—such as the American Institute of Steel Construction (AISC) formula.

The general form of the Johnson formula is:

$$\frac{P_e}{A} = a - b\left(\frac{L}{r}\right)^2 \quad (4)$$

in which constants a and b are usually chosen to make the parabola defined by this equation tangent to Euler's curve at $S_y/2$ with its vertex at S_y. For the conditions given in Fig. 2, point B ($L/r = 107$) defines the point of tangency and Eq (4) becomes:

$$\frac{P_e}{A} = S_y\left(1 - \frac{S_y (L/r)^2}{4 n \pi^2 E}\right) \quad (5)$$

For values of $L/r < 107$, Eq (2) results in permissible loads too large for material under elastic and plastic loading; for values of $L/r > 107$, Eq (5) permits loads too small to be satisfactory. A practical solution in machine design is to use both equations—each in its own range.

In other fields, however, more conservative parabolic formulas are used. For example, the AISC formula is:

$$\frac{P_a}{A} = 17{,}000 - 0.485\left(\frac{L}{r}\right)^2 \quad (6)$$

Eq (6) applies to steel only and where $L/r < 120$, and defines an allowable load. The n conditions are taken care of in the constant 0.485. In no case will the unit load exceed 17,000 lb/in.^{2}

A similar formula sponsored by the American Railway Engineering Association is:

$$\frac{P_a}{A} = 15{,}000 - 0.250\left(\frac{L}{r}\right)^2 \quad (7)$$

This is also for steel only, but with the conditions that $L/r < 140$ and the ends are riveted.

Straight-Line Formulas

Advantage of straight-line formulas is ease of application although the allowable loads are less than those of parabolic equations. For this reason many of the city building codes use straight-line formulas. For example, Chicago and New York City both use the equation:

$$\frac{P_a}{A} = 16{,}000 - 70\frac{L}{r} \quad (8)$$

Further limitation on Eq (8) is that P_a/A should not exceed 14,000 lb/in.^{2} This is shown by the broken line CDE in Fig. 2.

For machine design, a practical straight-line formula is one which is tangent to Euler's curve. It can be derived as follows for the conditions in Fig. 2.

The general equation of a straight line passing through point $P/A = S_y$, and $L/r = 0$ is

$$P/A = m\,(L/r) + S_y \quad 9\,(A)$$

Where m is the slope. For $n = 1$, Euler's equation becomes

$$\frac{P}{A} = \frac{\pi^2 E}{(L/r)^2} \quad 9\,(B)$$

Slope of Euler's equation is obtained by differentiating with respect to L/r:

$$m = -\frac{2\pi^2 E}{(L/r)^3} = -\frac{2\,P/A}{L/r} \quad 9\,(C)$$

Substituting Eq 9(C) into Eq 9(A) locates one coordinate of the point of tangency:

$$P/A = S_y - 2\,(P/A)$$

$$P/A = S_y/3 \quad 9\,(D)$$

Substituting Eq 9(D) into Eq 9(B) locates the second coordinate as: $L/r = 131$. Two points of the straight line are now known and by using the equation $y - y_1 = m\,(x - x_1)$, the formula becomes:

$$\frac{P_e}{A} - \frac{50000}{3} = \frac{-2\pi^2\,(29)\,(10^6)}{(131)^3}\left(\frac{L}{r} - 131\right)$$

$$\frac{P_e}{A} = 50000 - 254\frac{L}{r} \quad (10)$$

Thus, Eqs (10) and (2) can be used as a combination: Eq (10) for $L/r < 131$ and Eq (2) for $L/r > 131$. This

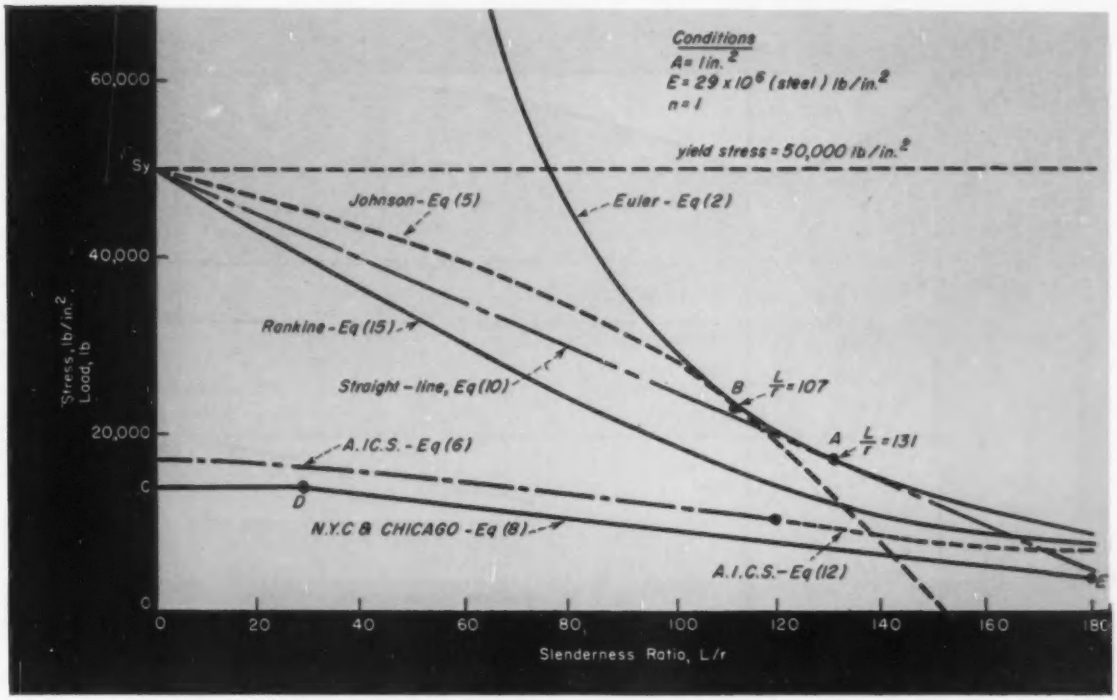


Fig. 2—Comparison of column formulas.

gives slightly more conservative values than the combination of Eq (5) with Eq (2).

Rankine's Formula

Euler's formula, Eq (2), is based on the assumption that the direct compressive stress is insignificant, thus limiting it to very long columns. Johnson's formula, Eq (5) places more emphasis on direct stress; this limits it to short columns. Rankin's formula, which is empirically derived, attempts to use both load conditions to determine the total unit load. The formula is of the form:

$$\frac{P_c}{A} = \frac{S_y}{1 + K\,(L/r)^2} \tag{11}$$

where K is a constant determined either mathematically from the condition that Eq (11) approaches Euler's for very long columns, or experimentally based on material variations and end conditions. (For experimental values of K, see "Introduction to Mechanical Design" by Jefferson and Brooking, p 39, Ronald Press 1951, New York.)

The AISC specifies the following formula of the Rankine type for ratios between $L/r = 120$ and $L/r = 200$ to be used in combination with Eq (6):

$$\frac{P_a}{A} = \frac{18{,}000}{1 + \frac{1}{18{,}000}\left(\frac{L}{r}\right)^2} \tag{12}$$

However, to satisfy the condition that Rankine's formula approaches Euler's for large values of L/r, Eqs (2) and (11) are equated:

$$\frac{\pi^2 E}{(L/r)^2} = \frac{S_y}{1 + K\,(L/r)^2}$$

For large values of L/r, the first term unity in the denominator of the equation can be dropped. Then

$$\frac{\pi^2 E}{(L/r)^2} = \frac{S_y}{K\,(L/r)^2}$$

$$K = \frac{S_y}{\pi^2 E} \tag{13}$$

and Eq (11) becomes:

$$\frac{P_c}{A} = \frac{S_y}{1 + \frac{S_y}{\pi^2 E}\left(\frac{L}{r}\right)^2} \tag{14}$$

For the conditions in Fig. 2, Eq (14) becomes:

$$\frac{P_c}{A} = \frac{50{,}000}{1 + \frac{1}{5700}\left(\frac{L}{r}\right)^2} \tag{15}$$

When plotted in Fig. 2, Eq (15) seems to be the ideal column formula since its curve starts with the yield stress and approaches Euler's curve for high L/r ratios. However, for intermediate column lengths, Eq (15) gives values that are too conservative and thus finds little use where weight or cost is an important factor. For this reason, the combination of Eq (5) with Eq (2) is preferred.

EDITOR'S NOTE—For design of aluminum columns, the government spec ANC-5 recommends Euler's equation for long columns and Johnson's generalized equation —modified by material constants—for short columns. A table of material constants for common aluminum alloys, plus nomograms for solving the above equations are included in the article "Allowable Design Loads for Aluminum Columns" by Martin A. Rubinstein, *Product Engineering*, August 1952, page 197.

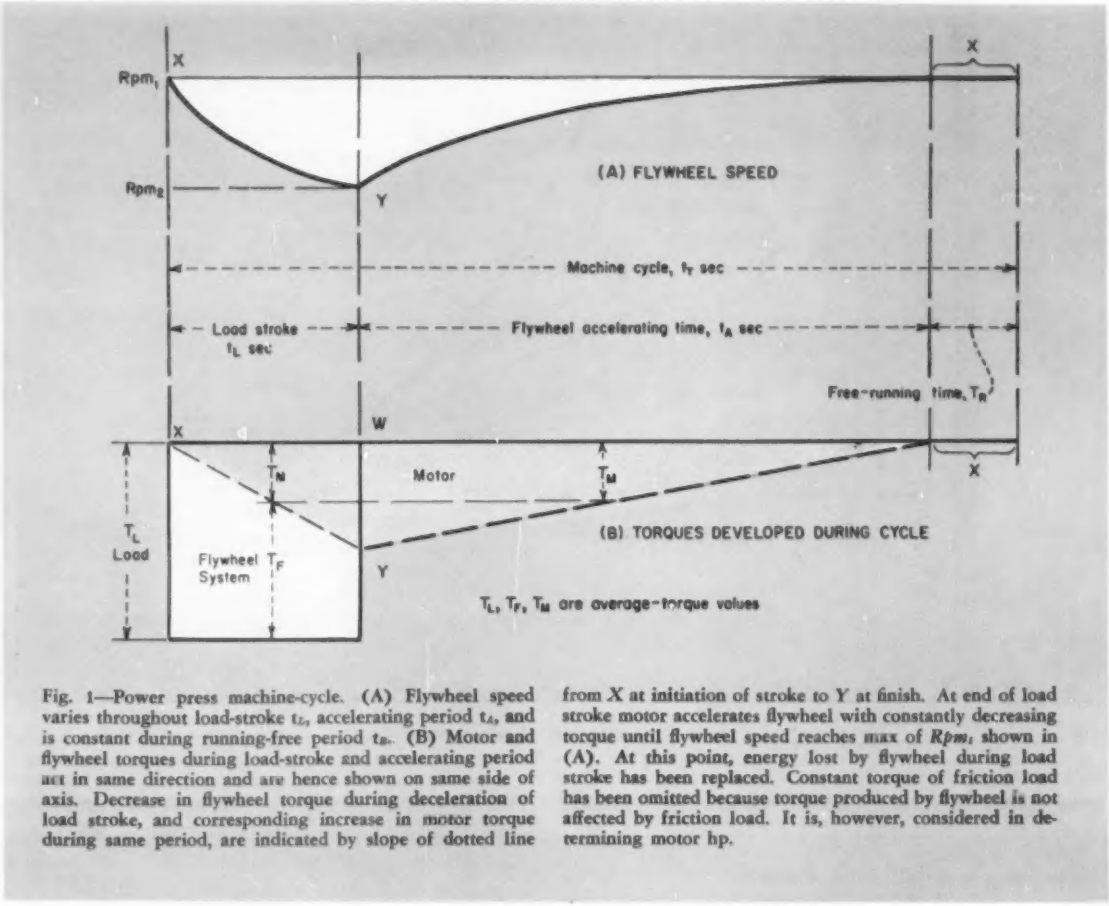


Fig. 1—Power press machine-cycle. (A) Flywheel speed varies throughout load-stroke t_L, accelerating period t_A, and is constant during running-free period t_R. (B) Motor and flywheel torques during load-stroke and accelerating period act in same direction and are hence shown on same side of axis. Decrease in flywheel torque during deceleration of load stroke, and corresponding increase in motor torque during same period, are indicated by slope of dotted line from *X* at initiation of stroke to *Y* at finish. At end of load stroke motor accelerates flywheel with constantly decreasing torque until flywheel speed reaches max of Rpm_2 shown in (A). At this point, energy lost by flywheel during load stroke has been replaced. Constant torque of friction load has been omitted because torque produced by flywheel is not affected by friction load. It is, however, considered in determining motor hp.

How to select the best combination of flywheel inertia and motor for the cyclic power requirements of a constant-running machine such as a punch press; data on motor speed-torque characteristics under cyclic loads. A time-saving yet precise procedure based on analysis of a large number of typical drives.

Driving High-Inertia Loads

CHARLES C. LIBBY
Manager, Electrical Dept., Fairbanks, Morse & Co., Fairlawn, N. J.

SELECTION OF FLYWHEEL SYSTEM elements and drive motor for applications such as punch presses, draw-presses, shears, pellitizers, or riveting machines requires an integrated evaluation of flywheel and motor dynamic and torque characteristics. Simplified method presented here for calculating flywheel inertia and motor hp, and selecting motor NEMA Design type is developed on basis of two significant factors: S, ratio of change in flywheel speed during work stroke to maximum flywheel speed, also called coefficient of fluctuation; and A, ratio of average torque supplied by flywheel to average load torque required during the work stroke.

Speed-change ratio *S* is important because it is directly related to the amount of expended flywheel energy, and consequently the work provided by flywheel; *S* also approximates maximum slip of a properly applied motor. For any motor type, proper choice of *S* determines portion of speed-torque curve over which motor is operated during machine cycle. Ratio of flywheel and load torque **A** is

NOMENCLATURE

A	Ratio of average flywheel-system torque T_F to average load torque T_L.
E	Kinetic energy of flywheel system, ft lb.
E_F	Work done by flywheel system during speed-change Rpm_1-Rpm_2, ft lb.
E_L	Work performed during load stroke, ft lb.
Hp_{E1}	Rms motor hp produced during load stroke and accelerating period.
Hp_{E2}	Rms motor hp produced during entire machine cycle.
Hp_{FR}	Hp required to overcome machine friction load.
Hp_M	Calculated required motor hp.
R	Ratio of max motor hp during load stroke to calculated motor hp.
Rpm_1	Maximum flywheel speed, rpm.
Rpm_2	Minimum flywheel speed, rpm.
S	Ratio of change in flywheel speed during load stroke to maximum flywheel speed, or $\frac{Rpm_1 - Rpm_2}{Rpm_1}$
T_F	Average flywheel-system torque developed during load stroke, lb ft.
T_L	Average required load torque, related to flywheel speed, lb ft.
T_M	Average motor torque developed during load stroke or flywheel accelerating time, lb ft.
t_A	Flywheel acceleration time, sec.
t_L	Load stroke time, sec.
t_R	Running-free time, sec.
t_T	Machine-cycle duration, sec; $= t_L + t_A + t_R$
WR^2	Inertia of all rotating or reciprocating elements of flywheel system, lb ft^2.
WR^2_{EQ}	Equivalent WR^2 of motor rotor at flywheel speed, lb ft^2.
WR^2_{FC}	Flywheel-system inertia corrected for motor rotor inertia, $= WR^2 - WR^2_{EQ}$.
WR^2_M	Inertia of motor rotor, lb ft^2.

important because it provides a relationship in terms of both torque and times ratios. Use of time ratios simplifies design calculations.

Basic Machine-Cycle Relations

In punch-press operation, speed and torque of flywheel and drive motor vary over functional portions of machine cycle, as shown in Fig. 1. Flywheel and motor are connected by gears, chains, or belts, and their speeds vary in the same ratio. At instant load-stroke portion of cycle begins, at left in (A), flywheel speed is a maximum, Rpm_1; torque exerted by flywheel system is also a maximum, as shown at left in (B). Kinetic energy E_F of flywheel system at maximum speed Rpm_1 is given by:

$$E = \frac{WR^2\,(Rpm_1)^2}{5880} \tag{1}$$

During load stroke, flywheel speed decreases to minimum Rpm_2, producing maximum percentage of torque and work required to perform machine task. Work done by flywheel system E_F during this speed change is equal to:

$$E_F = \frac{WR^2\,(Rpm_1)^2 - (Rpm_2)^2}{5880} \tag{2}$$

Factoring,

$$E_F = \frac{WR^2\,(Rpm_1 + Rpm_2)\,(Rpm_1 - Rpm_2)}{5880} \tag{3}$$

The ratio S is equal to ratio of total variation in speed to maximum speed, or:

$$S = \frac{Rpm_1 - Rpm_2}{Rpm_1} \tag{4}$$

Rearranging

$$Rpm_2 = Rpm_1 - S(Rpm_1) \tag{5}$$

Substituting Eq (5) into Eq (2) and simplifying:

$$E_F = \frac{WR^2\,(Rpm_1)^2\,S(2 - S)}{5880} \tag{6}$$

Reducing,

$$= \frac{WR^2\,(Rpm_1)^2\left[S\left(1 - \frac{S}{2}\right)\right]}{2940} \tag{7}$$

Similarly, average flywheel-system torque T_F developed during load stroke can be given as a function of S:

$$T_F = \frac{WR^2\,(Rpm_1)\,S}{308t_L} \tag{8}$$

During load stroke it is assumed, Fig. 1(B), that average load torque T_L acting over t_L sec is sum of average torques developed by decelerating flywheel system and by motor T_M as related to flywheel speed, or $T_L = T_F - T_M$. Torque T_F is a maximum at the beginning of the load stroke, but drops to a minimum at the end. In order to maintain constant average torque during load stroke additional torque T_M is provided by motor. T_M is zero at beginning of stroke and maximum at end, at which point flywheel and motor speed are a minimum. Since flywheel and motor are connected by gears, chains, or belts, motor and flywheel speeds decrease in identical proportions during load stroke, and S is the same value for both.

Motor Speed-Torque Cycle

A typical speed-torque curve of a NEMA Design D motor applied in a power press is shown in Fig. 2(A). Flywheel inertia and work-stroke duration have been properly proportioned to motor type and hp rating so that motor operates in relatively flat portion of curve between X and Y, retracing this portion once each machine cycle.

Maximum flywheel and motor speed Rpm_1 occurs when machine is running with only friction load, such as during free-running time t_R shown in Fig. 1(B). In Fig. 2(A) approximately 25 per cent of motor torque is required to overcome machine friction, and consequently torque at X or starting point of work cycle is to the right that amount on torque curve. Once each work stroke, motor develops maximum of 180 per-cent rated torque at Y. In Fig. 2(A) value of S has been chosen to agree with flywheel system requirements; this basically determines per cent maximum torque load on motor and consequently required hp rating. Average per-cent torque developed, corresponding to T_M, is 103 per cent of rated torque.

Effect of not allowing sufficient time for flywheel to accelerate to maximum speed between load strokes is indicated in Fig. 2(A). In a proper design, flywheel speed cycles between Rpm_1 and Rpm_2 or between points X and Y

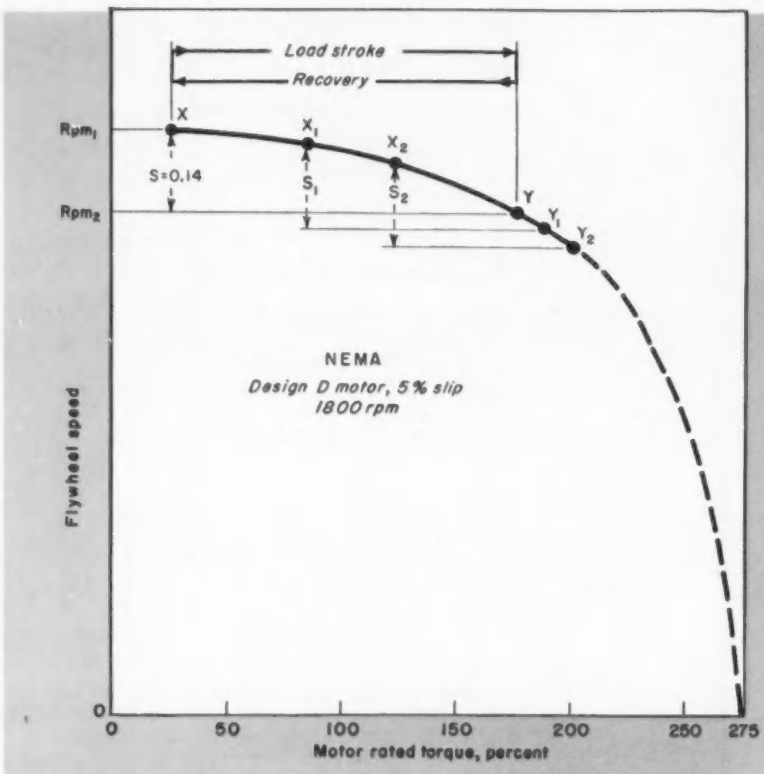


Fig. 2—Motor speed-torque curves showing ranges of required motor torques during machine cycle as determined by chosen value of *S*. (A) Motor indicated is properly applied when *S* has value of 0.14; motor torque T_M increases from 25 per cent at max flywheel speed Rpm_1, point *X*, to 180 per cent at slowest flywheel speed Rpm_2, point *Y*. If flywheel accelerating period is reduced, flywheel does not have time to reaccelerate to Rpm_1 at *X*, but rises only to speed corresponding to X_1; several cycles later speed decreases, for example to X_2, where increased average motor torque keeps flywheel speed cycling between points X_2 and Y_2. Flywheel speed and torque decrease correspondingly, producing undesired increase in motor load. (B) Machine-cycle load and *S* of flywheel system of (A) applied to NEMA Design C motor. Max speed Rpm_1 is same at *X* but *S* of 0.14 extends max torque requirements into unstable portion of curve at *Y*, and hence motor is not recommended for this application.

which correspond to those same points on Figs. 1(A) and (B). If acceleration time t_A is reduced so that flywheel cannot reach Rpm_1, it reaches some lesser speed such as at point X_1 on the curve. The repeating load stroke drops motor speed again, for example to point X_2, until increase in motor torque at lower average speed produces stabilized operation between two points on the curve, such as between X_2 and Y_2. Net effect of these higher average torques is an undesired increase in motor load.

Speed-torque curve of a NEMA Design C motor with rated hp equal to that of the Design D motor at (A), is shown in (B). This motor should not be applied to the same machine as the Design D because the value of 0.14 for S here causes maximum required torque at the end of the work stroke to fall at point Y in the unstable operating region. This motor could only be successfully applied to a machine which had an S value of approximately 0.09. Thus, the value of S is also of importance in determining motor Design type.

Selecting Values for *S* and *R*

Based on experience, typical values of S in Table I have been selected for 1800-rpm squirrel-cage, 3-phase motors. This type of motor has been chosen because it is standard, smallest, and most economical in sizes normally used for this type application.

Friction-load values in Table I are based on estimates of friction loss in driven machines. Values of S in the column for 20 to 30 per cent friction are used for typical power presses. For presses with high number or weight of rotating parts, values of S in the 40 to 50 per cent column are used.

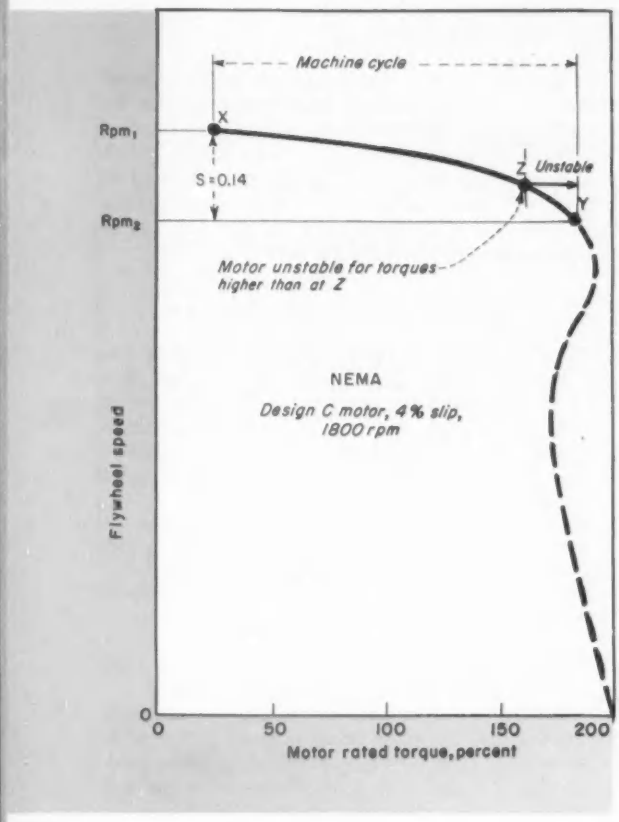
Max-hp ratio *R* is a factor which, when multiplied by required motor hp (to be later calculated) equals maximum hp required to be developed at end of load stroke. The several values of *R* have been chosen by motor designer so that maximum motor torque required at end of load stroke will not exceed a safe fraction of breakdown torque of NEMA Design type indicated; this allows operation of motor within the essentially flat portion of torque/speed curve, as shown in Fig. 2(A). A safety factor has been incorporated in the values of *R* for Design D motors since exact full-load slip of an individual motor cannot be accurately predicted by motor manufacturer in such high-slip designs.

Determining Flywheel Inertia

First step in determination of flywheel-system inertia WR^2 uses Eq (8) rearranged as follows:

$$WR^2 = T_F \frac{308 t_L}{(Rpm_1)\, S} \qquad (9)$$

At this point, however, neither WR^2 nor flywheel-system torque T_F are known; only required average load-torque T_L, in lb ft adjusted to flywheel speed and required for t_L sec, appears in preliminary designer's data shown in Table



II. Value of T_F can be obtained by first determining ratio of flywheel torque to load torque, or T_F/T_L, which can be calculated from data already established, Table II, as shown in the following derivation.

Energy produced by flywheel system during load stroke deceleration in terms of flywheel-torque T_F and load-stroke time t_L is:

$$E_F = \frac{T_F\, t_L\, (Rpm_1)\, (2 - S)}{19.1} \tag{10}$$

Energy absorbed by flywheel during acceleration-period t_A is equal to that lost during load stroke, or $E_F = E_A$; this is supplied by motor and in terms of average motor-torque T_M and acceleration time t_A, is:

$$E_A = \frac{T_M\, t_A\, (Rpm_1)\, (2 - S)}{19.1} \tag{11}$$

Setting Eq (10) equal to (11) and reducing:

$$T_L\, t_L = T_M\, t_A \tag{12}$$

Total average load torque is the sum of motor and flywheel-system torques, or $T_L = T_M + T_F$. Motor torque is the difference between load and flywheel torques, or $T_M = T_L - T_F$, and substituting this in Eq. (12):

$$(T_L - T_F)\, t_A = T_F\, t_L \tag{13}$$

Multiplying and rearranging,

$$T_L\, t_A = T_F\, (t_L + t_A) \tag{14}$$

and

$$\frac{T_F}{T_L} = \frac{t_A}{t_L + t_A} = A \tag{15}$$

A is the ratio of torque supplied by flywheel system to load torque. Since this is also the ratio of accelerating time to load stroke plus accelerating time, which times have already been established in Table II, T_F can be obtained from Eq (15), or:

$$T_F = T_L \left(\frac{t_A}{t_L + t_A} \right) \tag{16}$$

or,

$$T_F = T_L\, A \tag{17}$$

Since A represents proportion of load stroke torque supplied by flywheel system, remainder is furnished by drive motor. Where A = 0.75 or greater, acceleration time is equal to or greater than four times load stroke, or $t_A = 4\, t_L$.

Power presses with less than 10 machine cycles per minute are usually of heavy design, and load stroke duration is relatively long. When these presses have infrequent or non-periodic load strokes, it may be more practical to set flywheel-acceleration time t_A equal to three or four times loadstroke time t_L, and allow motor to run free for t_R seconds, rather than use entire time between load strokes for flywheel acceleration. In these heavy presses an intermittant-duty motor in a reduced frame size may be applied; this can be evaluated by method later described under "Calculating Effective Horsepower."

Flywheel system inertia can now be determined by first choosing value of S from Table I. Next, solving Eq (16) for flywheel-system torque T_F and substituting this value in Eq (17) to obtain load torque T_L, values of S, A, and T_L can finally be inserted in Eq (18), which is then solved for inertia.

$$WR^2 = A \left[\frac{T_L\, 308\, t_L}{S\, (Rpm_1)} \right] \tag{18}$$

At this point both flywheel inertia and the relative value of Rpm_1 can be adjusted to meet mechanical requirements. Where it is desired to solve for inertia in terms of work performed during load stroke E_L, previously given in Table II, Eq (19) may be used.

$$WR^2 = A \left[\frac{E_L\, 2940}{(Rpm_1)^2\, S \left(1 - \frac{S}{2} \right)} \right] \tag{19}$$

Selecting Motor Hp

Required motor power Hp_M may be now calculated using flywheel-system inertia WR^2 determined in Eqs (18) or (19). Torque T_F required to accelerate flywheel system through working speed range S (Rpm_1) must equal average accelerating torque developed by motor in same relative speed range if load strokes are to continue without reducing flywheel and machine cycling speed below nominal motor operating speed. Average torque required to accelerate flywheel, at flywheel speed, is:

$$T_M = \frac{WR^2\, (Rpm_1)\, S}{308\, t_A} \text{ lb ft} \tag{20}$$

Average developed motor accelerating torque T_M at flywheel speed is:

$$T_M = \frac{5252\, [R(Hp_M) - Hp_{FR}]}{2\, (Rpm_1)\quad (1 - S)} \tag{21}$$

where R is chosen from Table II on basis of value of S

Table I—Initial Calculation Factors for Determining Required Motor Type and Hp for Power Press Applications

Machine-cycle Frequency, cycles-per-min	Motor Design Type and Slip	Flywheel Speed-Change Ratio S for Friction Loads of		Max-Hp Ratio R
		20–30%	40–50%	
Less than 10	*NEMA D* 8% to 13% (10% assumed)	0.20	0.18	1.5
10 to 40	*NEMA D* 5% to 8% (5% assumed)	0.14	0.13	1.7
40 or more 5 hp and larger	*NEMA C* 3% to 5% (4% assumed)	0.09	0.08	1.4
5 hp and larger	*NEMA B* 2% to 3% (3% assumed)	0.03	0.25	1.2
3 hp and smaller	*NEMA B* 2% to 3% (2% assumed)	0.035	0.03	1.7

used, Hp_M is unknown value of required motor hp, and Hp_{FR} is power required to overcome machine friction, taken from data in Table II.

In order for motor to have sufficient hp, Eqs (20) and (21) must be equal. Setting Eq (20) equal to (21) rearranging terms and simplifying, Eq (22) is solved for motor hp, or:

$$Hp_M = \frac{WR^2\left(\frac{Rpm_1}{100}\right)^2 S\,(1-S)}{R\,(t_A)\,81} + \frac{Hp_{FR}}{R} \qquad (22)$$

If final calculated hp rating in Eq (22) exceeds next lower commercial rating by more than 10 per cent, next larger commercial size should be chosen.

Compensating for Motor Inertia

Calculated values of WR^2 in Eqs (18) and (19) are flywheel-system inertias which include equivalent inertias of all rotating or reciprocating elements of drive, all related to flywheel speed. In most press designs, flywheel inertia represents at least 75 per cent of total, with second most significant inertia found in rotor of drive motor. Since motor hp has been determined in Eq (22) correction may now be made for motor-rotor inertia $(WR^2)_M$ by subtracting equivalent value of this inertia at flywheel speed $(WR^2)_{EQ}$ from flywheel system inertia. Hence:

$$WR^2_{EQ} = \left(\frac{\text{Motor rpm}}{\text{Flywheel rpm}}\right)^2 (WR^2_M) \qquad (23)$$

and corrected flywheel system inertia $WR^2_{FC} = WR^2 - WR^2_{EQ}$.

If it is desired to reduce flywheel-system inertia to lowest possible value for a given flywheel speed and motor hp, use a motor with a high-inertia rotor rather than a standard type. (PRODUCT ENGINEERING Sept. 1955, p 129). High inertia axial-air-gap motors are available in ratings up to 15 hp at 1800 rpm; these motors have rotor inertias from 4 to 11 times that of old NEMA frame motors and 5 to 15 times that of new NEMA rerated frames.

Calculating Effective Horsepower

Comparison of rms hp produced by motor during machine cycle with calculated hp Hp_M will disclose if a smaller, more economical intermittent-duty motor may be used. Rms or effective hp Hp_{E1} developed during load-stroke t_L and accelerating-period t_A is equivalent to one-half maximum hp developed during this time, related to speed corresponding to maximum hp, or:

$$Hp_{E1} = \frac{R\,(Hp_M)}{2\,(1-S)} \qquad (24)$$

Rms hp Hp_{E2}, for entire machine cycle, which includes running-free time t_R, is equal to:

$$Hp_{E2} = \sqrt[2]{\frac{(Hp_{E1})^2\,(t_L + t_A) + (Hp_{FR})^2\,t_R}{t_L + t_A + t_R}} \qquad (25)$$

Where machine cycle permits motor to run free with only light friction load for 40 per cent or more of the time, or when rms hp is less than 60 per cent of hp rating calculated in Fig. (22), use of an intermittent-duty motor will be satisfactory. This should be checked with motor designer.

Application of Method

As an example of the use of this method assume the following initial design data as set up in Table II.

1. Average load torque T_L adjusted to flywheel speed, 425 lb ft.
2. Machine-cycle analysis
   a. Machine-cycle repeats 10 times per minute; cycle time t_T, 6 sec.
   b. Load-stroke time t_L, 1 sec.
   c. Flywheel accelerating time t_A, 5 sec.
   d. Running-free time t_R, 0.
3. Max flywheel speed Rpm_1, 600 rpm.
4. Hp required to overcome friction Hp_{FR}, 5 hp.

It is desired to use an 1800-rpm open motor geared to load. Since machine-cycle repeats 10 times per minute, Table I indicates NEMA Design D, 10 or 5 per cent slip, 1800-rpm motors are possible selections. The 10 per cent slip motor is chosen here because it permits use of smaller flywheel. Five per cent motor could be alternate solution requiring a larger flywheel.

Assuming a friction load of 25 per cent, S is chosen from Table I to be 0.20 and R is 1.5. From data given above and Eq (15), A is calculated:

$$A = \frac{t_A}{t_L + t_A} = \frac{5}{5+1} = 0.834$$

From data and Eq (18), flywheel-system inertia is calculated:

Table II—Preliminary Design Data for Determination of Flywheel Inertia and Speed, and Motor Hp and NEMA Design Type. (See Fig. 1)

1. *Work-stroke load on flywheel shaft.*
   a. Average load torque T_L in lb ft adjusted to flywheel speed and required for t_L sec, or
   b. Useful work E_L performed during load stroke' ft. lb.
2. *Machine-cycle breakdown.*
   a. Duration of load stroke t_L, sec.
   b. Flywheel accelerating period t_A, sec; equal to $t_T - t_L - t_R$.
   c. Time machine runs free t_R, sec; normally zero except in machines with infrequent or nonperiodic load strokes.
   d. Machine-cycle duration t_T; equal to $t_L + t_A + t_R$.
3. *Maximum flywheel speed Rpm_1, at beginning of load stroke, rpm.*
4. *Hp required to overcome machine friction load, Hp_{FR} (estimated or measured).*

$$WR^2 = 0.834\left[\frac{(1)\ (308)\ (425)}{(0.20)\ (600)}\right]$$
$$= 909 \text{ lb ft}^2 \text{ at flywheel speed.}$$

From Eq (22), motor hp, Hp_M, can now be calculated:

$$Hp_M = \frac{909\left(\frac{600}{100}\right)^2 (0.20)\ (1 - 0.20)}{(1.5)\quad (81)\quad (5)} + \frac{5}{1.5}$$
$$= 12.0$$

The solution indicates that a 15-hp Design D, 8-13 per cent slip, 1800-rpm continuous duty open motor can be applied. Maximum slip will be approximately 10 per cent.

If it is desired to reduce flywheel inertia, a motor with a high-inertia rotor can be used. Rotor inertia of the Design D motor chosen in NEMA frame 326 is 2.5 lb-ft. In this example it is assumed that at flywheel speed this corresponds to an equivalent inertia of 31.5 lb ft², and flywheel inertia can therefore be reduced by 31.5 ft-lb² from 909 to 877.5 lb ft². Use of an axial-air-gap motor of same rating with rotor inertia of 18.2 lb ft² produces, at flywheel speed, added effective inertia of 173 lb ft². In this case flywheel inertia can be reduced from 909 to 737 lb ft².

To determine if intermittent duty motor can be used, rms hp is calculated, first using Eq (24)

$$Hp_{R1} = \frac{(12\ (1.5)}{(1 - 0.2)\ (2)} = 11.2$$

then Eq (25)

$$Hp_{R2} = \sqrt[2]{\frac{(11.2)^2\ \ 6}{6}} = 11.2$$

Since t_R is zero in this case, Hp_{R1} equals Hp_{R2}. Comparison of 11.2 rms hp to 15-hp motor selected verifies that continuous-duty motor is required, since rms hp is greater than 60 per cent of rated hp.

EDITOR'S NOTE—*Additional Reading:* Other articles evaluating factors involved in selection and application of motors for machine-tool drives have appeared in earlier issues of PRODUCT ENGINEERING. A comparison between conventional NEMA motors and axial-air-gap high-inertia motors is made in "Axial-air-gap Motors for Machine Tool Drives" September 1955 page 129. Method of calculating flywheel effect of motor rotors is also included.

"The Significance of WK² and How to Calculate It," 1954 Annual Handbook issue page H25, derives the method of calculating moments of inertia of various shaped parts and includes approximations for calculating WK² for flywheels, spur or helical gears, and motor rotors. A data sheet "Calculating Mass Moments of Inertia," January 1956 page 214, provides means for quickly calculating moments of inertia for cross sections of any shape.

"The Importance of Duty Cycle in Selecting Polyphase Induction Motors," November 1954 page 174, presents a detailed analysis of NEMA Design B, C, and D torque and speed ratings. "How Big A Motor?" September 1952 reviews four methods for determining proper motor rating for duty-cycle operations: calculating from motor data, using load-torque tests, making metered running tests, and taking temperature rise on heat run.

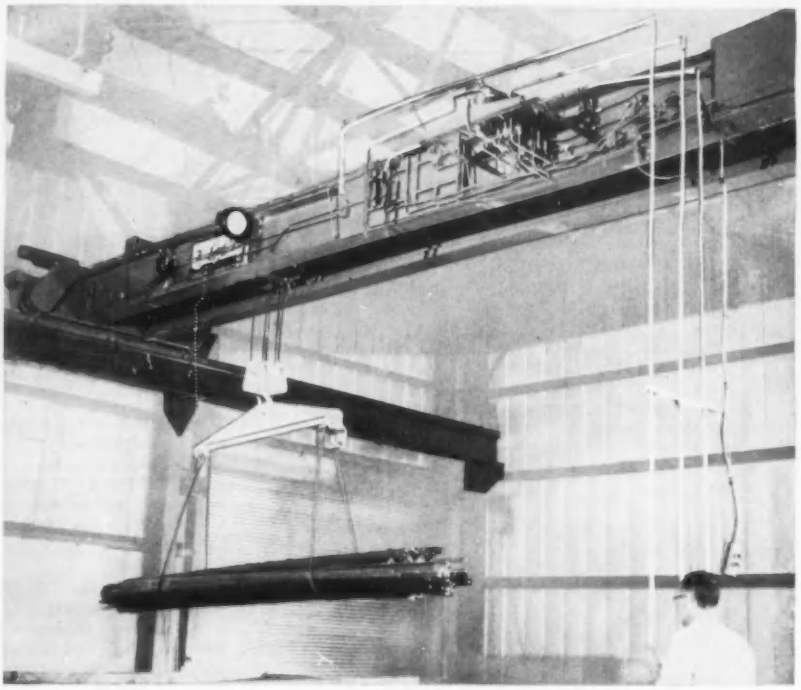
Nonprofit Qualifying Agency for Materials Suggested

NOW BEING CIRCULATED by the Society of Automotive Engineers for Charles M. Miller, a Northrop Aircraft Inc. materials engineer, is a questionnaire soliciting the opinion of people in industry regarding the formation of a nonprofit qualifying agency to furnish tests for materials acceptable to both consumer and producer. Mr. Miller has suggested that industry support a nonprofit organization which would draw up lists of approved materials and their specifications based on data supplied by independent test laboratories.

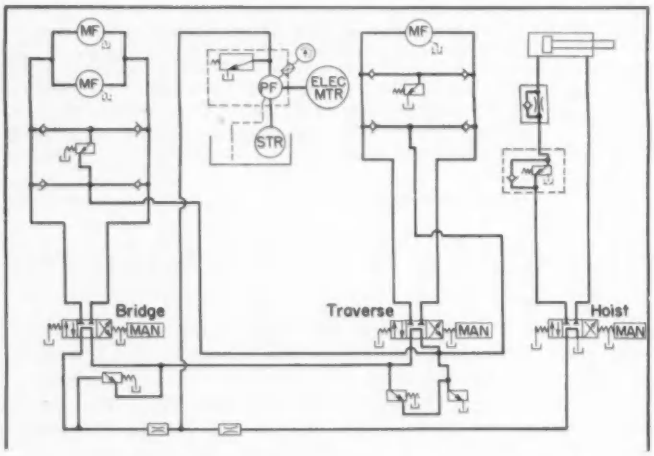
Besides the materials in general use, the list also would include the newer materials such as metallic molybdenum, titanium alloys, ceramics, powder metal materials, new elastomers for high temperature hydraulic fluid packing applications, heat resistant transparent materials, and radiation altered materials. Some of these are in the same experimental stage titanium was, not too long ago, and for which specifications are now becoming available.

Mr. Miller feels that while several agencies like the Aeronautical Material Specification Div. of the SAE are now issuing procurement specifications, there is a need for a central agency to approve the materials to these specifications. The agency could function like the Underwriters Lab. does in the electronic, safety and other fields.

Such an agency would have the following benefits, according to Mr. Miller: (1) Provision of a basis for buying or selling by publishing lists of qualified products; (2) Assurance to the ultimate consumer of greater safety in use of the end products; (3) Reduction of delays in the schedule by providing approved product lists in advance of need; (4) Release of staffs of producer and user from routine qualification testing, and the provision of a test facility available to those who have no technical staffs; and (5) The producer would not have to supply material for testing to prospective users.



CRANE SPANS 37 ft with a capacity of 3 tons. Pendulum controls on the right operate control valves for bridge, trolley and hoist. The lighter trolley and hoist systems allow a lower weight bridge structure—two I-beams diagonally braced at the top flange provide a simple structure with high lateral stability.

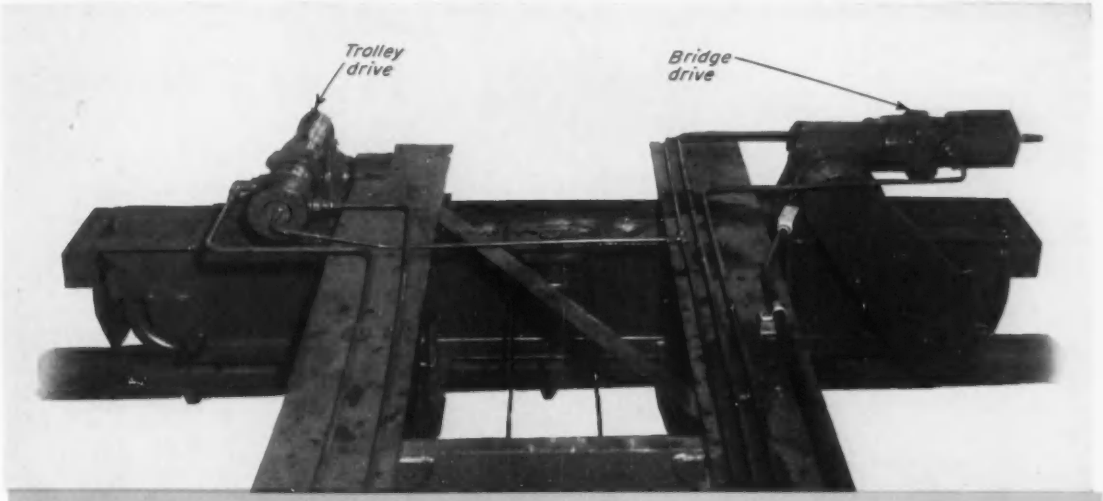


THE HYDRAULIC CIRCUIT is supplied from a single Dudco vane-type pump driven by a 10 hp squirrel-cage motor; pump delivers 12 gpm at 2000 psi. Fluid is metered to bridge and hoist circuits by flow control valves and the trolley control valve is in series with the bridge control valve. All controls are manual four-way throttling valves to provide infinite speed variation. Braking action for bridge and trolley drives is obtained with check and relief valves. A flow-divider synchronizes the two bridge drive motors and a valve in the hoist circuit limits lowering speed by acting as a counter-balance.

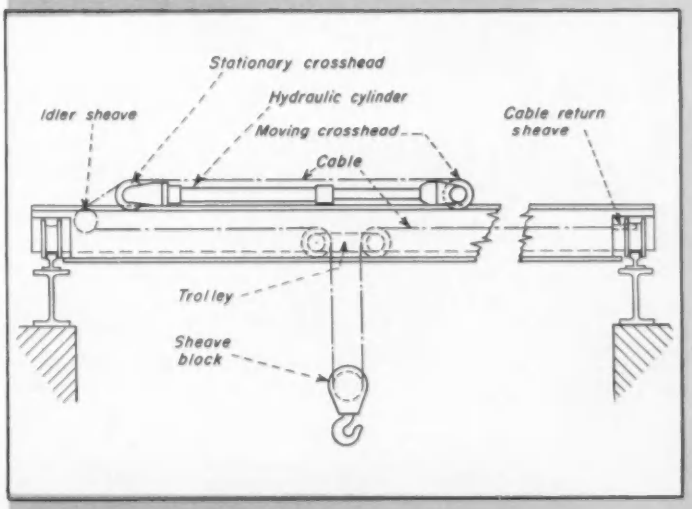
Hydraulic Crane

To obtain infinite speed variation at all loads, lower cost and reduced maintenance, the Shaw-Box Crane & Hoist Division of Manning, Maxwell & Moore Inc., Muskegon, Michigan has developed an overhead traveling crane with hydraulic drives. Replacing electric motors and controls with hydraulic system reduces weight of trolley and hoist units.

IN NEW PRODUCTS

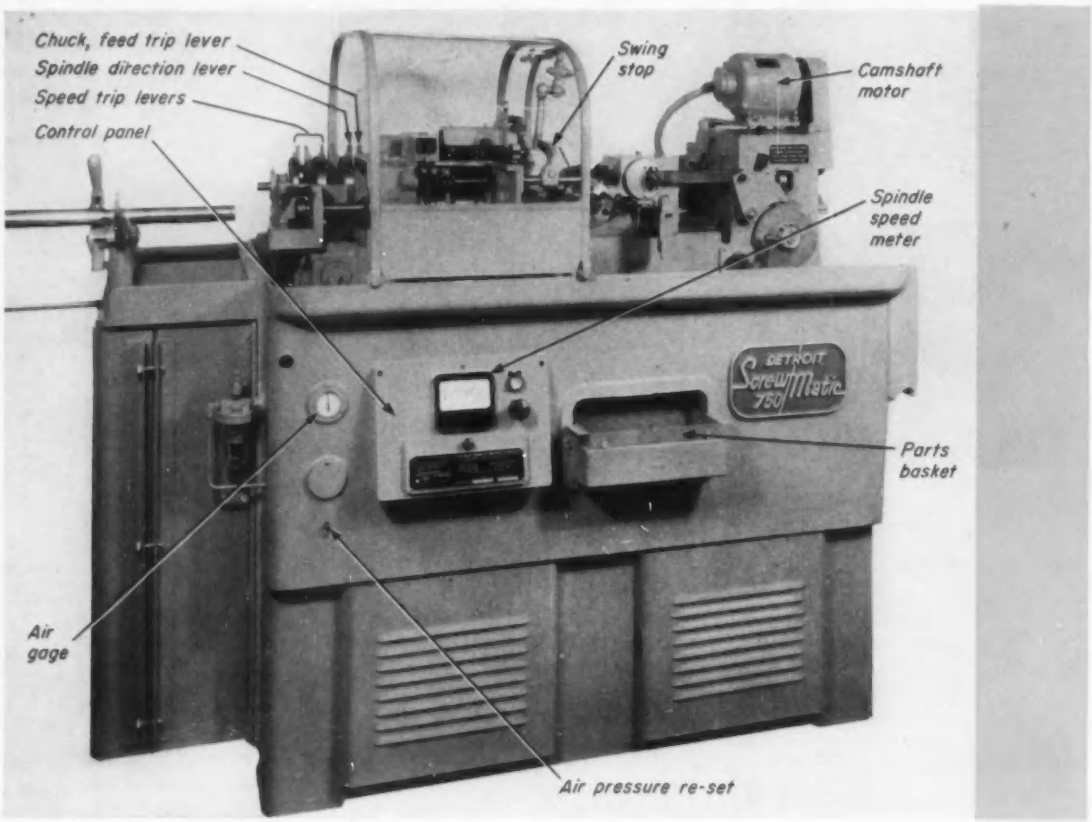


BRIDGE AND TROLLEY ARE DRIVEN by roller chain drives from Dudco vane-type motors flange-mounted to speed reducers. The bridge has a separate drive at each end—the trolley a single unit. The trolley is drawn across the bridge by concealed driving chains on rails welded to the bottom flange of each girder. The lightweight drives are simple and reliable.

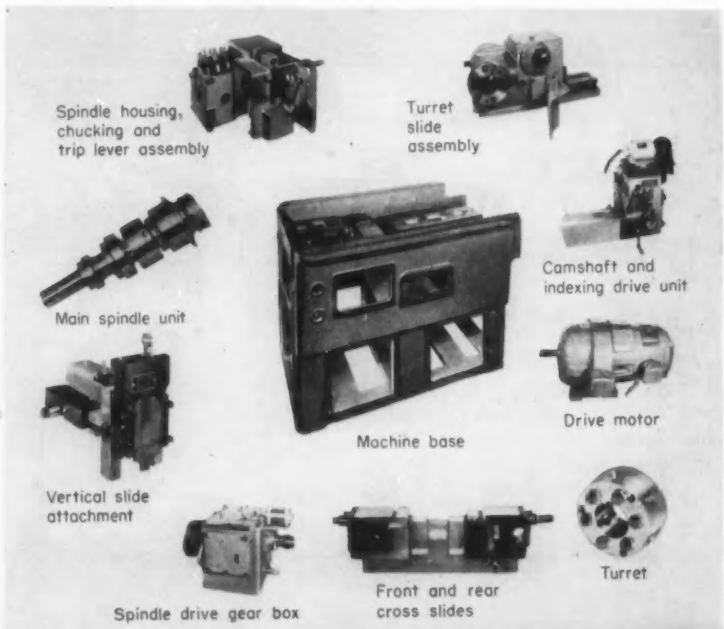


THE HOIST MECHANISM is powered by hydraulic cylinder which drives a ball-bearing crosshead along the top of the bridge girders. Moving and stationary crossheads each have six cable sheaves—providing 6 ft of cable motion per foot of cylinder stroke. The sheave block moves half this distance. Trolley motion does not change sheave block elevation as the cable length remains constant.

PRODUCT DESIGNS



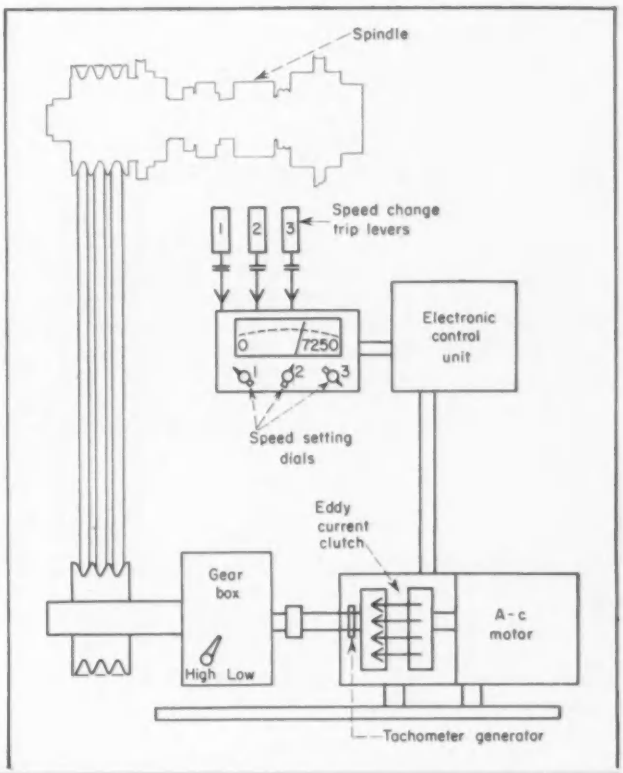
FEED, CHUCK AND SWING STOP are operated pneumatically, simplifying the machine design through lesser number of mechanical elements. Smoother, more accurate feed is another advantage claimed for the pneumatic control. Shop air supply furnishes 80 psi system; should pressure fall below 70 psi, machine automatically shuts off. Camshaft is at rear of machine, away from falling chips; machine front is clean and large chip storage area is made available. Note trip levers at left of spindle housing and the associated dog carriers. Spindle direction can be reversed at any time during cycle without stopping machine. All controls are covered except start-stop buttons.



EACH BASIC MACHINE component (shown right) is either keyed or doweled to the respective support unit and secured by bolting. Thus, slideways can be replaced when worn past gib adjustment, and the spindle can be changed in less than ten minutes.

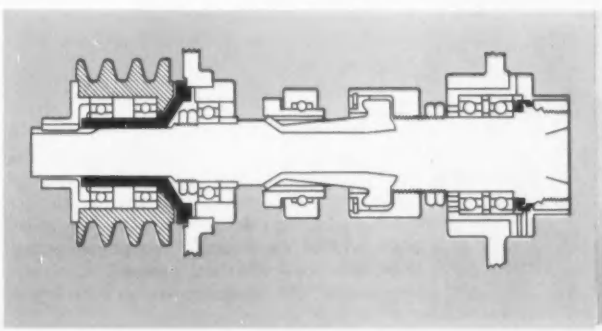
Unitized Screw Machine

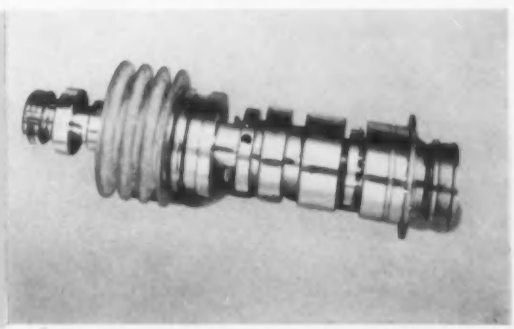
The Detroit "Screwmatic 750" manufactured by the Gear Grinding Machine Co., Detroit, consists of ten easily removable basic components. Pre-selected multiple spindle speeds can be automatically sequenced during the machining cycle. The belt driven spindle carries no transmission load as sheave is mounted on separate bearings in spindle housing.



THE THREE-SPEED CYCLE is set up by adjusting speed selector dials on control panel; these dials establish the amount of d-c to be fed to the eddy-current clutch. Trip levers are actuated by carrier dogs at pre-determined intervals in the cycle, energizing potentiometer circuits in the control unit. A Louis-Allis drive provides infinitely variable speed, which is regulated by a tachometer generator signaling back to the control unit. Forward and reverse cone clutches, air actuated, are mounted in the gear box. The steel-corded V-belt drive is self-adjusting in tension, as transmission and drive are trunnion-mounted on a spring-loaded jack. The spindle bearings carry no belt load.

SPINDLE OPERATES UP TO 7250 RPM (with 7½ hp motor). Note separate sheave bearings and that spindle carries no clutch mechanism. Spindle is driven by pulley through the key shown below. Double row angular contact bearings at nose are factory pre-loaded for zero clearance. These bearings are protected by mechanical labyrinth and drain as shown.

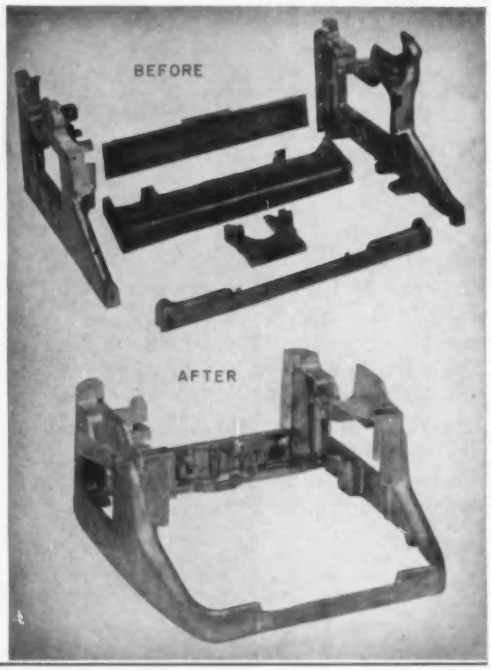




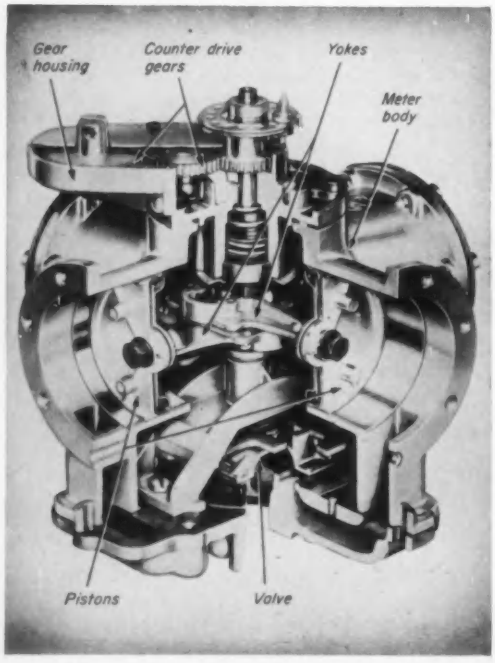
Designed For

To Replace 6 Parts

Underwood Corp., Hartford, Conn., redesigned the frame of their standard typewriter as an aluminum die casting instead of an assembly of iron sand castings. The result is increased rigidity, reduced weight and fewer machining operations.



USE OF A SINGLE CASTING makes many fasteners and other small parts unnecessary; the non-porous surface of the die casting does not require a primer coat for finishing. The gate (not shown) bridges the top of the casting and is retained during the machining cycle to provide extra rigidity for dimensional accuracy. The one-piece frame has dimensional stability not obtained with assembled construction. Open design simplifies assembly and service.

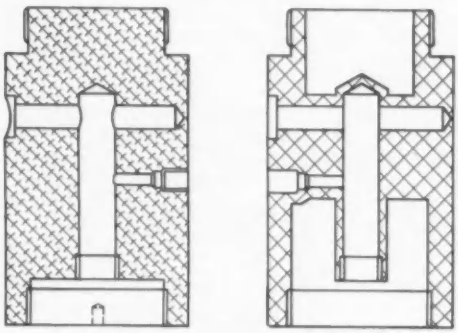


Using 3 Metals

Aluminum is used for lightness and strength, zinc for close tolerances, manganese bronze for abrasion resistance—in a gasoline pump meter developed by A. O. Smith Corporation, Los Angeles, California.

TO AVOID LEAKAGE AT JOINTS, aluminum meter body is cast in one piece with cored holes for mounting components. The gear assembly housing, spider and two yokes are also die cast aluminum. Stainless steel facings are cast as inserts in each yoke to form bearing surfaces for the crank journal. The pistons and counter drive gears are zinc die castings. The pistons run in stainless steel liners and have leather cup packings. Gears run on bronze bushing inserts. The manganese bronze valve is self-lapping because it has high abrasion resistance.

Die Casting



With Same Ballistic Characteristics

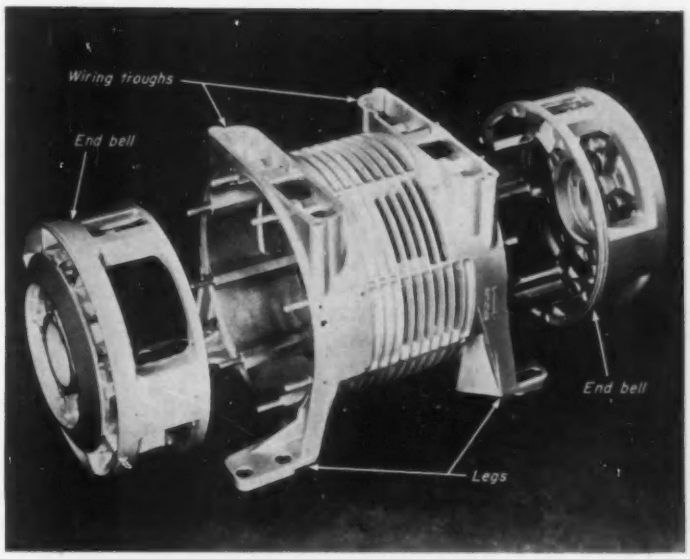
Monarch Governor Company of Willow Run, Michigan redesigned this fuse body as a zinc die casting with the same ballistic characteristics as the machined aluminum part that was previously used.

THE DIE CASTING had to be designed to weigh the same as the aluminum part and only a slight shift of the center of gravity was permissable. This was accomplished by using zinc with its higher specific gravity. Three holes, formerly drilled and tapped, are now cored and take expansion plugs instead of screws. The castings are dichromate dipped; the machined part required anodizing. Threads are cut by a special machine.

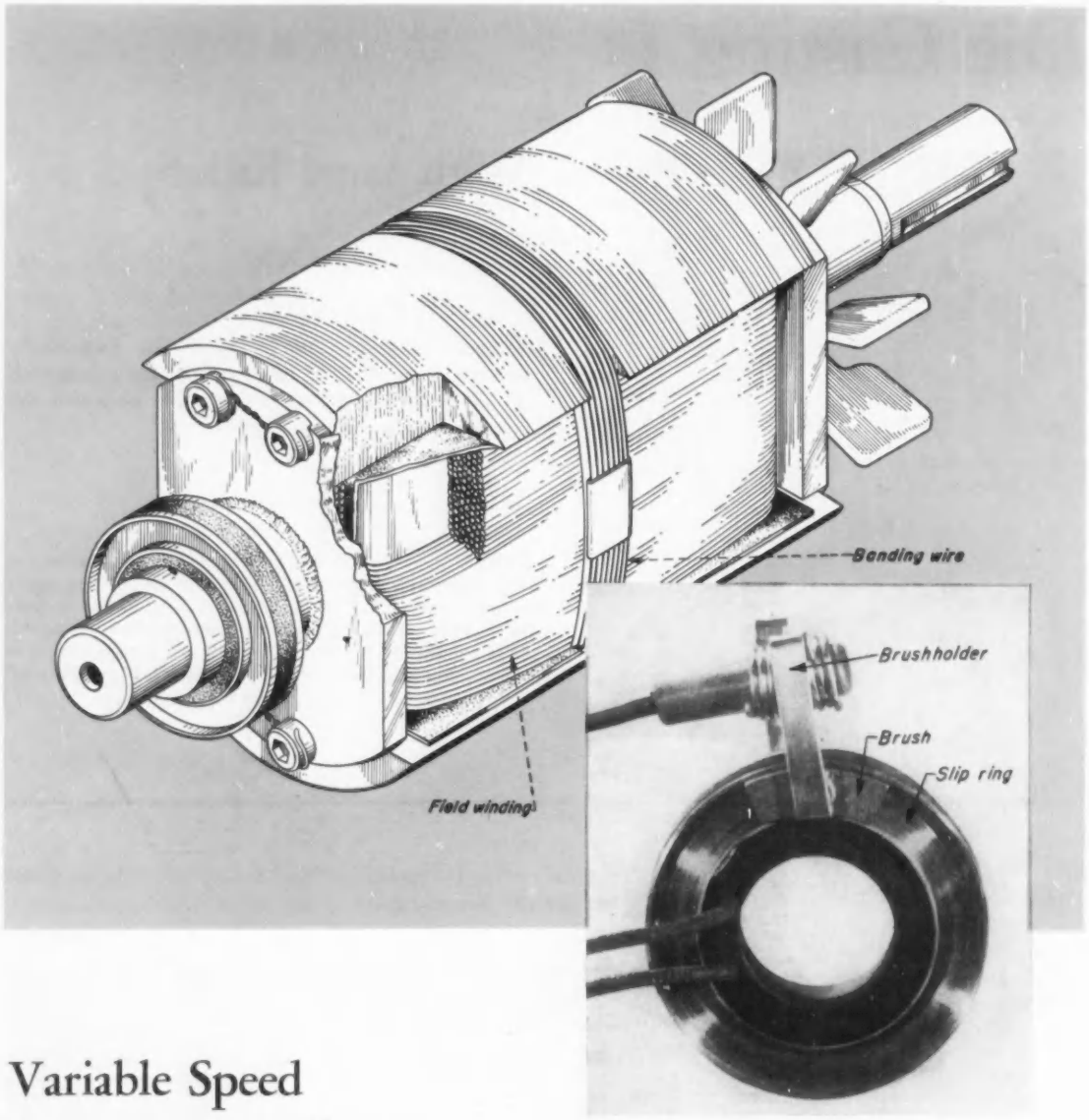
To Reduce Cost

A magnesium die casting has replaced 5 sand castings of the same metal in an aircraft inverter housing made by Jack & Heintz Co., Cleveland.

COST OF THE SAND CAST CENTER SECTION was too high; the main housing, two leg castings and two wiring troughs were cast and machined separately. The single die casting eliminates many assembly and machining operations and reduces the cost of the housing by over 40 per cent. The part is made in a one-cavity die with what is said to be the largest magnesium die casting machine in this country. Die cost was amortized over the first 1800 pieces of the year's 5000 piece production.



EDITOR'S NOTE: In addition to these four examples see case histories in "Redesign for Die Casting" appearing in January 1956 page 156. Also, in the 1955 Handbook issue, page D-12, "Design Tips for Changing to Die Castings," which includes recommendations for bosses, cored holes, lugs and ribs.

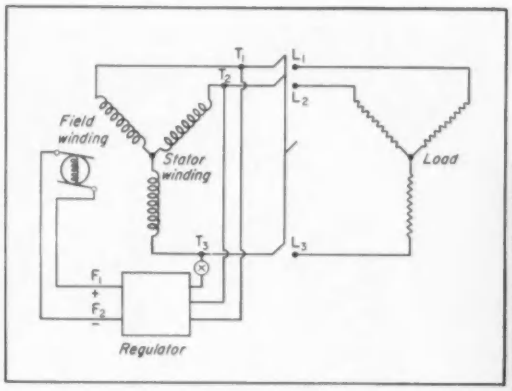


Variable Speed Generator-Regulator

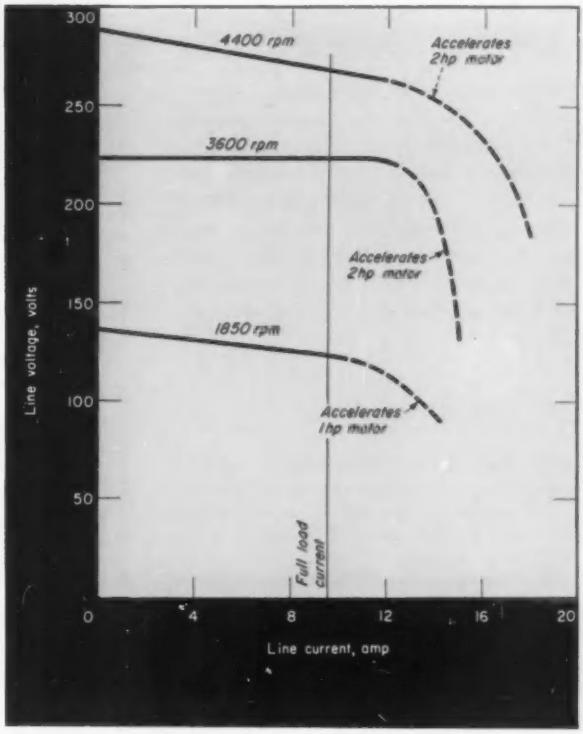
A generator-regulator that develops a linear voltage-frequency relation from 1800 to 6000 rpm has been produced by Star-Kimble, Bloomfield, N. J., in conjunction with Fidelity Electric Co., Lancaster, Pa. This "Mo-bil-ac" unit can start and provide constant torque characteristics for motors having ratings approximately that of the generator. Solid cast rotor, flat-end brackets and a special slip ring and brush assembly make for a compact generator.

ROTOR HAS NO THROUGH-SHAFT, is high carbon steel casting; support is by means of end-flanges. Flat end brackets are used instead of conventional curved type, to reduce housing length. Solid rotor design makes possible fuller use of field winding space than does conventional through-shaft construction. Also, with no winding build-out along shaft, mechanical strength of the rotating member is improved. The rotor surface is grooved to aid heat dissipation and to reduce pole surface losses. The 2-pole revolving-field generator has nominal speed of 3600 rpm.

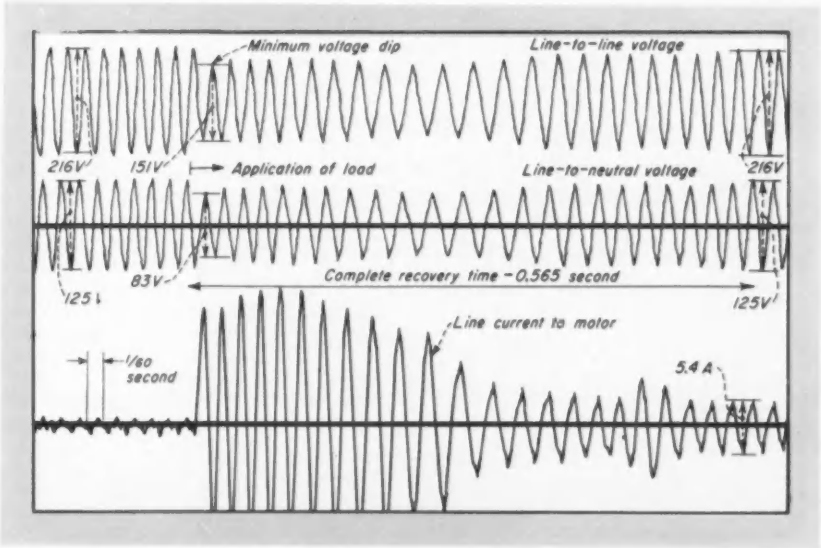
The slip ring and brush assembly (inset) requires less rotor shaft length than conventional two-brush design. The rings are mounted on each face of the insulating member; the brushes spring-retained by the brush arms operate on the slip ring faces. Conventionally, the slip rings are mounted side by side with the brushes on the ring OD.



THIS SYSTEM CAN BE USED for an induction motor power supply; terminal voltage can be maintained proportional to frequency from 30 to 100 cy. The regulator incorporates magnetic amplifiers with selenium rectifiers, and has a frequency-sensitive circuit to provide constant field current independent of speed.



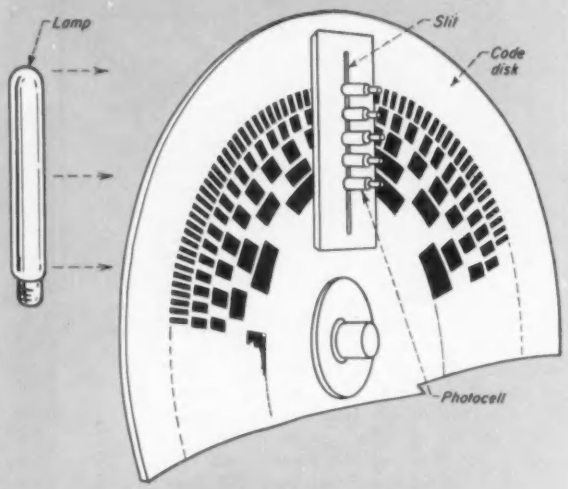
LOAD CHARACTERISTICS for a 3 kw 3-phase 3600 rpm unit operated at three different speeds. At 4400 rpm, unit accelerates a 2 hp motor. A past problem has been to start motors with hp ratings almost equal to that of the generator; the generated voltage invariably collapsed with a low impedance load across the terminals. This problem was solved by the high field-forcing capacity of the magnetic amplifiers.



SYSTEM RESPONSE TO across-the-line starting of a 1 hp motor driving a compressor. The maximum voltage drop was 30 per cent of normal voltage, recovery time 0.565 sec. Motor starting capacity can be further increased by use of regulator current feedback.

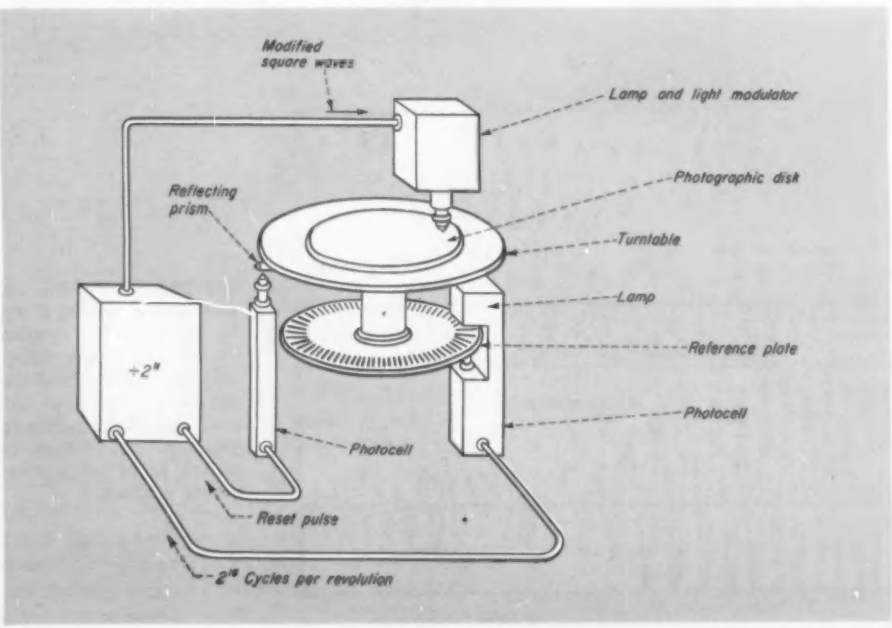
Air Bearing Levels Dividing Table

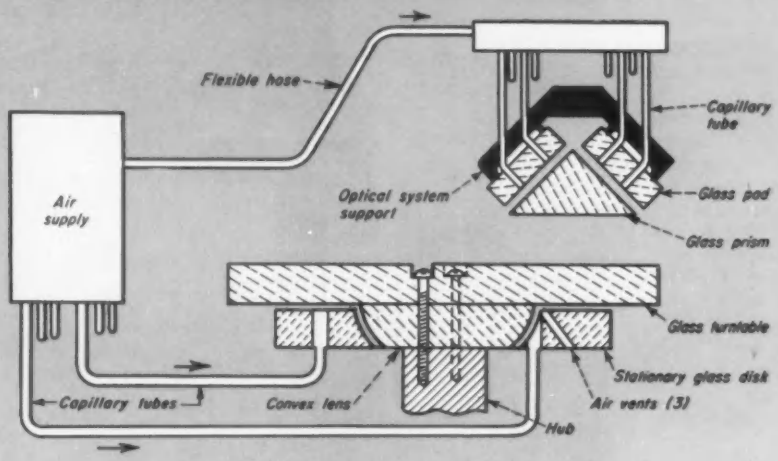
Master code wheels for angle digitizers made by the Baldwin Piano Company, Cincinnati, Ohio require angular graduations to an accuracy not obtainable with mechanical dividing engines. Photographic, electronic and mechanical principles, combined in a machine with dividing table leveled to one wavelength of light, produce the required accuracy.



HUNDREDS OF HOURS were required to produce disks by mechanical methods—but errors in engraving, etching and manual programming made them unsatisfactory. The Baldwin machine makes accurate disks in about 2 hours. Disks are used in analog-to-digital converters with 16-bit cyclic number outputs. Disk rotation controls photocell illumination to generate a set of signals unique for each position. Accurate coding requires that the radial pattern boundaries always be positioned to plus or minus 3 microns.

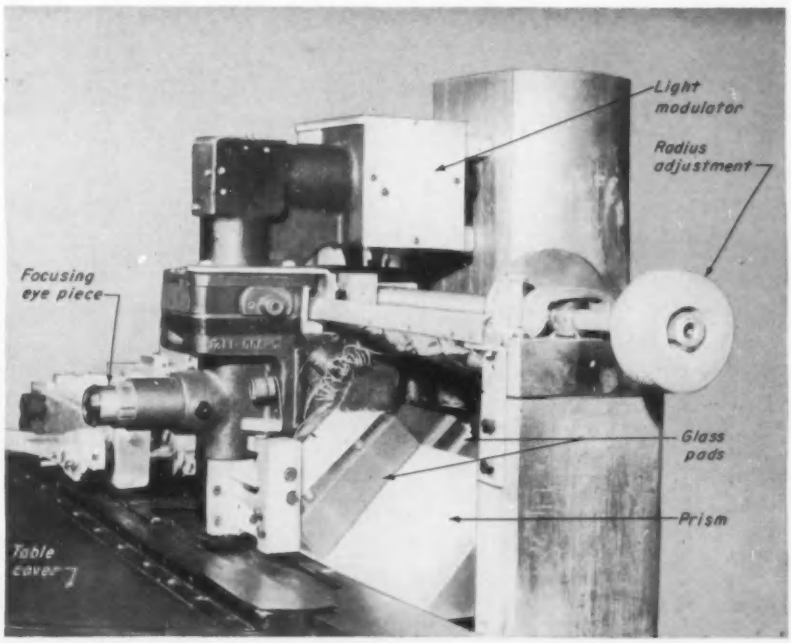
THE GLASS PHOTOGRAPHIC DISK is clamped to the dividing table and each track exposed individually. The light beam is modulated by electrical signals harmonic to the table rpm to produce the clear and opaque sectors; these signals are generated by a uniformly divided reference plate rotating with the table and an electronic frequency dividing system. Angular orientation of the tracks is accomplished automatically with a reset pulse which is generated at a fixed point in each table revolution.

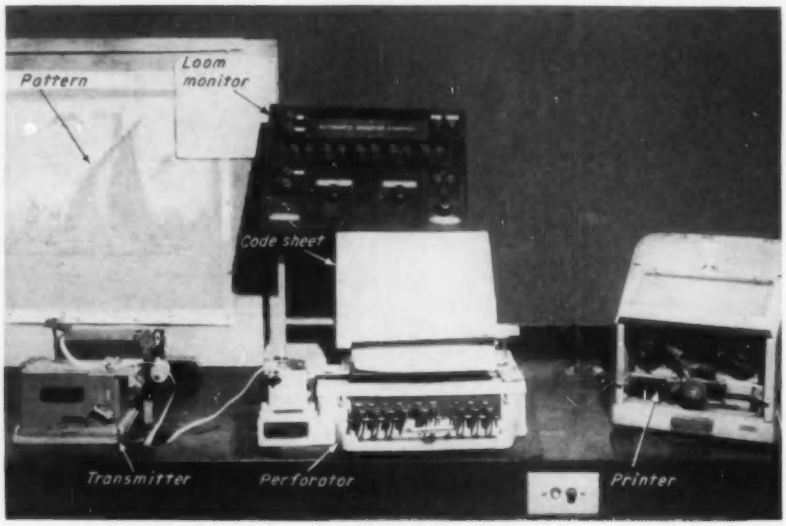




GLASS PARTS ARE USED WHERE tolerances of one wavelength of light are required. The turntable is a glass disk, flat to one wavelength, with sides parallel to five wavelengths—mounted on a plano-convex lens with surfaces spherical to a wavelength. The assembly is supported on an air cushion above a flat piece of glass with matching cavity and tolerances; the air is injected at three points on both the flat and concave surfaces. Interference fringes indicate that the table rotates in a plane and about a true center within approximately one wavelength. The table is driven by an aluminum disk which is the rotor of an eddy-current motor. A speed servo system monitors the reference plate signal to control the motor speed.

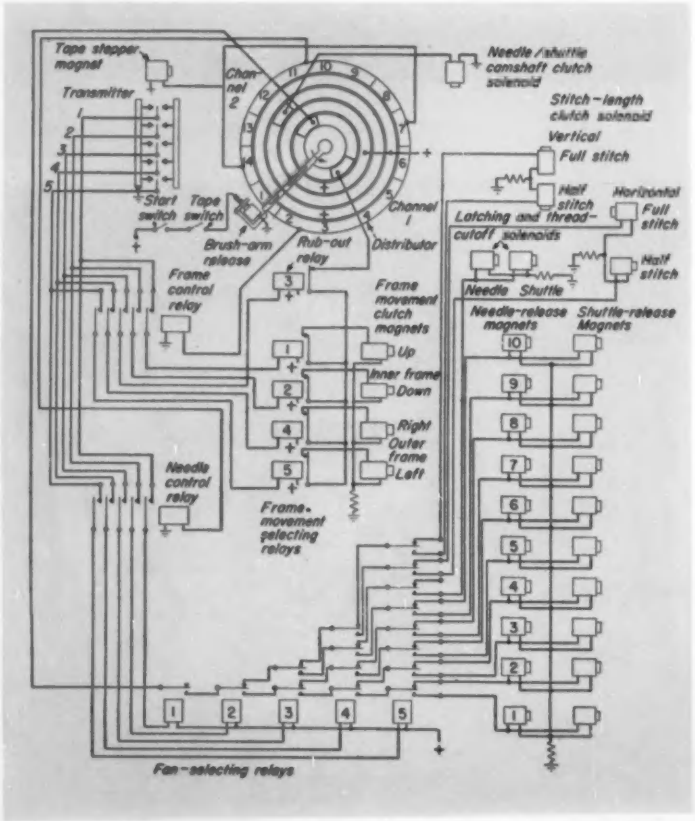
THE MAIN OPTICAL SYSTEM rests on two glass pads supported by an air cushion above a prism whose surfaces are flat to one wavelength. Air is injected at 4 points on each pad and interference fringes indicate position to a wavelength—accurately phasing tracks to a single radial line. The modified square waves produced by reference plate rotation operate the ribbons of a light modulating valve to control the exposure; ribbon motion is synchronized with disk rotation to prevent blurred images. The entire dividing unit is suspended on automobile coil springs to isolate building vibrations. All the electronic components are mounted in a separate cabinet to avoid heating the mechanical elements.





A 5-UNIT TWO-CHANNEL CODE is punched in paper tape and transmitted to machine in adjacent room. Transmitter reads code by means of sensing levers which make and break control circuits; distributor (not shown) relays transmitter signals to control elements mounted on machine. One tape channel controls frame movement, other channel controls needles, the two operations occurring intermittently. Printer shown checks code in pre-operation test run.

Remote Controls For Embroidery Machine

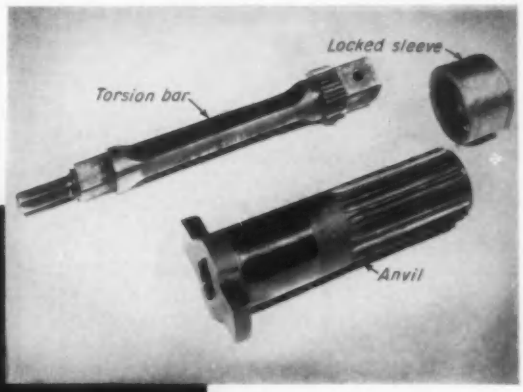


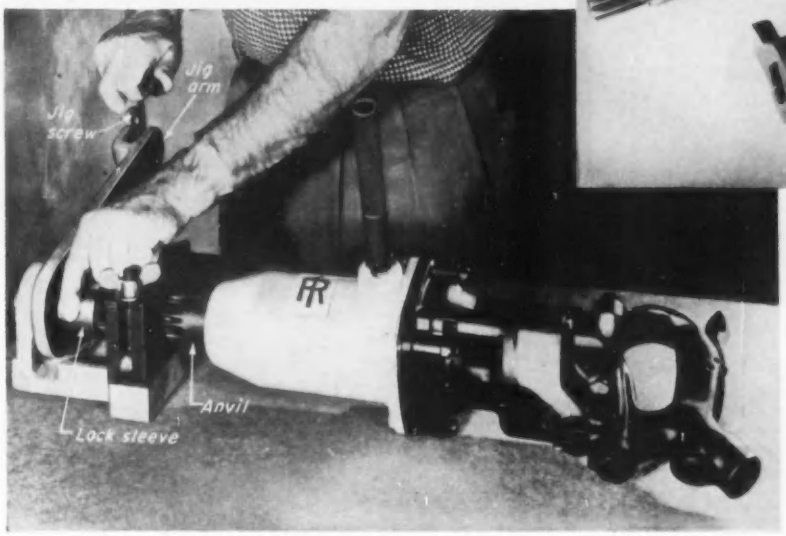
A remote control system for an embroidery machine has been designed by Louis Casper, Vice Pres., Electrotext Corp., New York City, which more than doubles conventional machine speed and permits ganged machine operation. Tape control is used, adapted from standard telegraphic apparatus. The system suggests possibility of remote control hook-up between cities.

ELECTRICAL SYSTEM, AS SHOWN, controls stitch direction (by frame movement), stitch length (by varying frame drive gear ratios), and single or multiple needle selection. Needle and shuttle latching is also solenoid-controlled. A single distributor and transmitter setup can be electrically plugged so to control any given number of embroidery machines. A rate of 500 stitches per minute has been achieved, with greater speed possible by building faster response into transmitter.

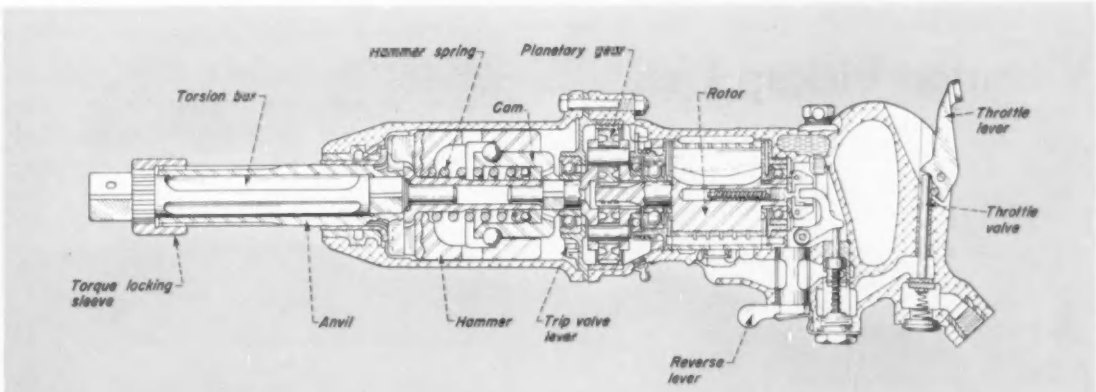
Pre-Stressed Bar Calibrates Impact Tool

Torque is controlled in the air-operated Ingersoll-Rand "Impactool" by a torsionally pre-stressed anvil member. When nut running resistance equals torsion bar stress, resulting hammer rebound trips valve, shutting off air supply. Releasing trigger re-sets the tool.

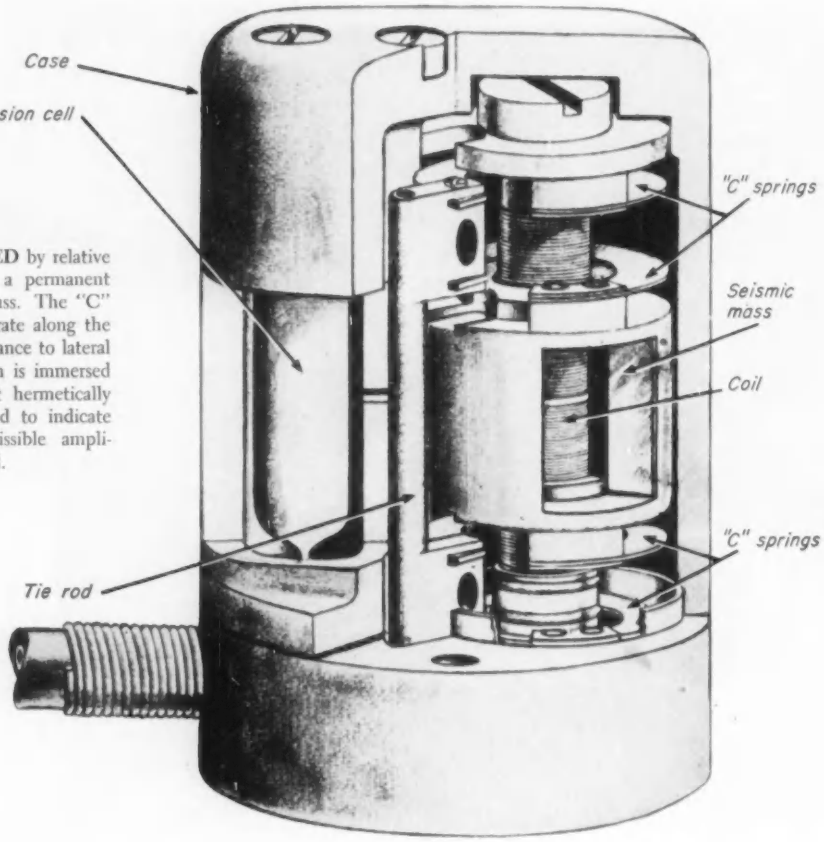




TOOL IS SET UP for torque adjustment by placing square driver in jig arm and clamping anvil as shown left. Jig screw is used to twist torsion bar to desired torque setting; anvil is then locked to bar by calibrated lock sleeve.



AIR MOTOR DRIVES rotary impact mechanism through gearing. The hammer, operating on a cam ball track, engages anvil through mating teeth. When nut resists turning torque, anvil is stopped but hammer continues turning; the hammer travels up anvil teeth, compressing the hammer spring. When hammer has traveled up full height of teeth, spring drives hammer forward, striking anvil and setting the nut. When nut impact resistance exceeds pre-stressed anvil torque, anvil rebound drives hammer along cam track, tripping shut-off valve (not shown). Torque setting remains constant.

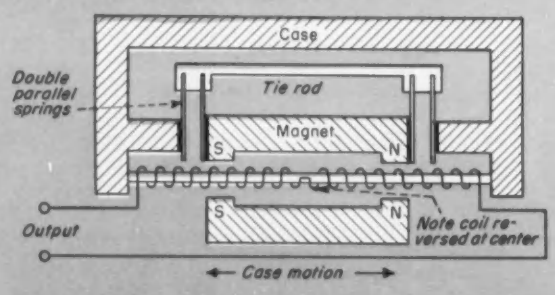


THE SIGNAL IS GENERATED by relative motion of a pickup coil and a permanent magnet which is the seismic mass. The "C" spring design has a low spring rate along the sensitive axis but has great resistance to lateral motion. The mass-spring system is immersed in damping fluid and the unit hermetically sealed. The output is amplified to indicate when vibrations exceed permissible amplitudes and correction is required.

Vibration Pickup Uses "C" Springs

Consolidated Electrodynamics Corp., Pasadena, California, supports the seismic mass of their vibration pickup on four "C" shaped flat springs which act as helical coil segments.

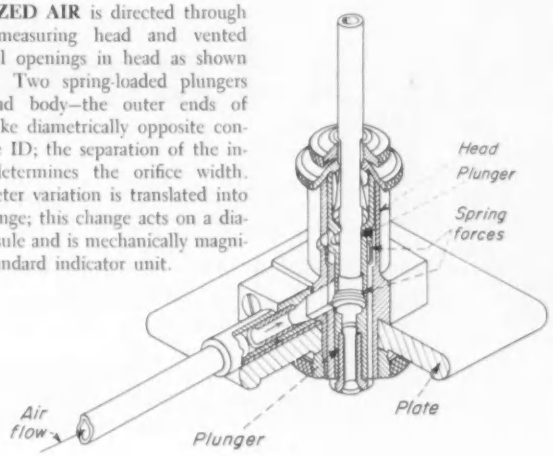
THE TWO HALVES of the pickup coil are wound in opposite directions and each half passes through oppositely polarized magnetic fields. Pickup from stray fields is cancelled while the vibration signals produced throughout the coil are in phase; this makes accurate readings possible at very low frequencies and amplitudes.

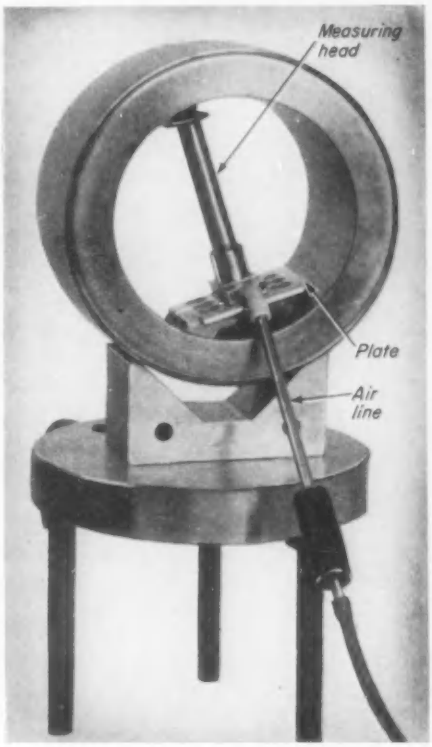


Pneumatic Comparator

A pneumatic comparator has been designed by the Metrology Div., National Physical Laboratory, England, to measure bore diameter variation axially and in azimuth, to 0.00001 in. Measurement is made by means of a pressure differential controlled by varying the width of the air jet orifice.

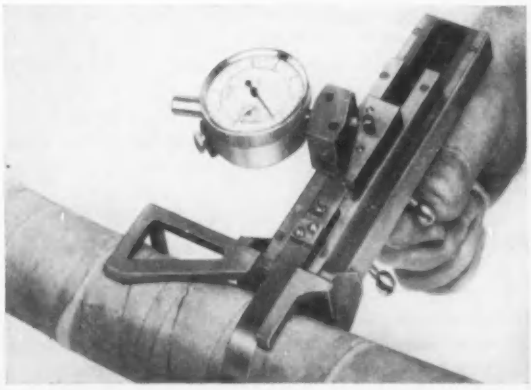
PRESSURIZED AIR is directed through orifice in measuring head and vented through wall openings in head as shown in drawing. Two spring-loaded plungers ride in head body—the outer ends of plungers make diametrically opposite contact on bore ID; the separation of the inner ends determines the orifice width. Thus, diameter variation is translated into pressure change; this change acts on a diaphragm capsule and is mechanically magnified in a standard indicator unit.

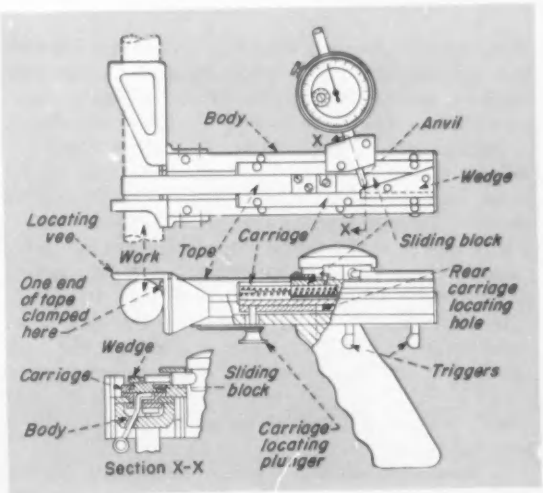




Mechanical Comparator

A comparator developed by the National Physical Laboratory mechanically measures average OD to 0.001 in. accuracy. A flexible steel tape which partly embraces the measured workpiece pulls against spring-loaded block; the pull is translated into direct gage reading by anvil riding on block-mounted wedge. The gun-like instrument design gives the user an easy grip.





A LOCATING VEE positions the measuring axis perpendicular to the longitudinal work axis. One end of the tape is clamped to the vee face; the other end is pin-latched to the block which slides in a horizontal carriage groove. Tape tension is maintained by a compression spring acting on the block. A gage anvil bears on the face of the wedge, the taper permitting a direct dial reading. Either trigger, when pressed, permits the tape to be unlatched from the block, depending on whether carriage is locked toward front or rear of body. Instrument measures increments between 1 and 2 in. dia.

Calculating Damping Factors for Dashpot Dampers

Evaluation of viscous damping factors of linear and rotary dashpot dampers on the basis of their dimensions and the viscosity of the damping fluid. With these equations designs may be synthesized on paper instead of using models requiring test and modification.

MANY DASHPOT DAMPERS are used in instrument and vibration isolation applications where damping characteristics require a precise match to associated equipment. In its simplest form this device consists of a piston operating in a cylinder with a small clearance between piston and cylinder wall, as shown in Fig. 1. A viscous fluid, trapped in the lower end of the cylinder is forced up through the annular clearance between cylinder and piston when a load is applied to the piston. Flow of oil past the piston causes a pressure rise in the trapped fluid proportional to the speed of the piston motion in the cylinder.

In the following derivation several assumptions are made which must be met closely in practice if the equations are to give accurate results. Where specific designs do not conform, correcting approximations must be made. Usually these are relatively simple variations on the derivation outlined below.

1. **Damping medium is a perfect fluid.** Most oils (including the silicones) with viscosities less than 200 centistokes are perfect fluids for damping purposes. If the fluid maintains "locked-in stresses", is dirty, or chemically unstable it will distort the response of a dashpot, particularly at low speeds.

2. **Clearance between piston and cylinder is small** relative to the piston diameter. This simplifies the computation considerably and is a perfectly acceptable assumption since, to get a damping factor of any appreciable magnitude clearances will have to be small.

3. **Piston must be long** enough to avoid sharp edge orifice effects.

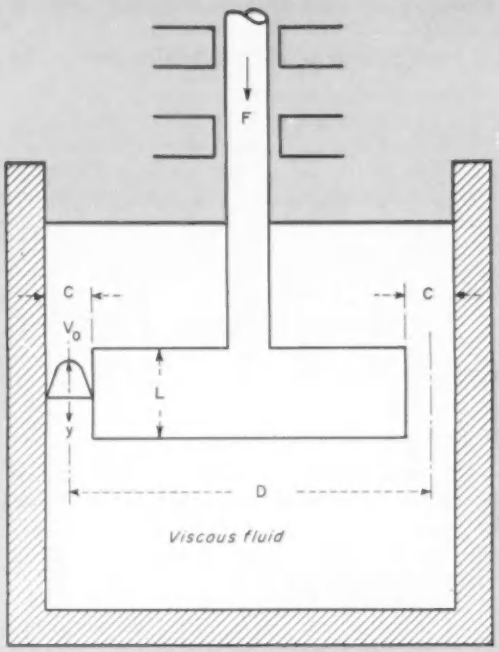
4. **Free area above piston must be large** enough so that oil velocity in this area approaches zero. If the piston rod is small very little oil is displaced as the piston moves into the cylinder and oil velocity above and below the piston approaches zero. Any reasonable ratio of piston to piston rod diameter (3:1 or greater) will reduce the oil velocity past the piston rod to a negligible value.

5. **Laminar flow is maintained** in the clearance between piston and cylinder at all times. At the viscosities and speeds of normal operation this is no serious limitation.

6. **Piston is maintained concentric with the cylinder** at all times. Some external method of guidance is required here since, if free to move laterally, the piston will choose to slide on one side of the cylinder wall. Damping will be reduced to 40 per cent of its previous value if this is permitted. Three buttons in the surface of the piston which bear on the cylinder wall may be used to control clearances, or external bearings for piston rod will serve the same purpose.

7. **Weight of the piston must be included** as part of the force acting on the trapped fluid in vertical installations.

8. **At very high speeds and damping factors,** forces may be high enough to drop the pressure on the piston below the vapor pressure of the fluid. Cavitation results and damping force is no longer proportional to speed.



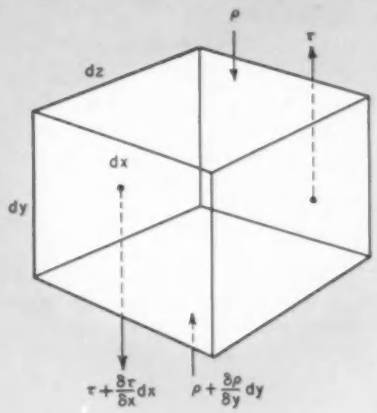


Fig. 1—Simplest form of linear dashpot damper. Variable x is measured from cylinder wall into the clearance between cylinder and piston. Fig. 2. Infinitesimal cube of fluid from the stream flowing alongside the piston. Increment of pressure is balanced by increment in viscous drag.

LINEAR DASHPOTS

Investigating an infinitesimal cube of oil from the volume in the clearance between piston and cylinder whose dimensions are dx, dy and dz a pressure balance exists as shown in Fig. 2. As the piston moves down, flow of oil is forced up. An increment of pressure serves to maintain this flow and this increment is

$$\frac{\partial p}{\partial y}\,dy$$

The total force on the bottom surface of the cube is pressure times area or

$$\frac{\partial p}{\partial y}\,dydxdz$$

Viscose drag operates in a similar manner on the side of the cube, and the incremental drag times lateral area which balances the pressure increment is

$$\frac{\partial \tau}{\partial x}\,dxdydz = \frac{\partial p}{\partial y}\,dydxdz$$

and

$$\frac{\partial \tau}{\partial x} = \frac{\partial p}{\partial y} \qquad (1)$$

but the definition of viscous drag establishes

$$\tau = \mu\,\frac{dv}{dx}$$

Differentiating this expression and substituting into equation (1) above

$$\frac{\partial p}{\partial y} = \mu\,\frac{\partial^2 v}{\partial x^2} \qquad (2)$$

Having assumed laminar flow, the velocity distribution in the clearance between piston and cylinder is parabolic as shown in Fig. 1. Speed of the piston is negligible in comparison to speed of oil in the passage (assumption 2) and so the boundary conditions permit writing an expression for the oil velocity as a function of x.

$$v = \frac{4\,V_o}{c^2}\,x^2 - \frac{4\,V_o}{c}\,x \qquad (3)$$

Where V_o is the maximum velocity of the oil midway between piston and cylinder. Note that v is negative for values of x between zero and c since it is opposite in direction to positive y.

Differentiating twice with respect to x establishes

$$\frac{\partial^2 v}{\partial x^2} = \frac{8V_o}{c^2} \qquad (4)$$

and substitution into equation (2) results in

$$\frac{\partial p}{\partial y} = \frac{8\mu V_o}{c^2} \qquad (5)$$

V_o may be established from an equivalence of flow. The piston, moving down at a velocity V displaces an amount of oil approximately $\frac{1}{4}\pi D^2 V$. The oil flows through the clearance whose area is approximately πDc

at an average velocity of $\frac{2}{3}$ V_o. (Average of a parabola is $\frac{2}{3}$ the maximum value.)

$$\frac{\pi D^2}{4} V = \frac{2}{3} V_o \pi D c$$

$$V_o = \frac{3}{8} \frac{VD}{c} \tag{6}$$

Substituting this value for V_o into equation (5)

$$\frac{\partial p}{\partial y} = \frac{3\mu VD}{c^3}$$

This pressure gradient is constant over the length of the piston, L, and so the total pressure build up between top and bottom piston faces is

$$p = \frac{3\mu VD}{c^3} L$$

and the total force acting on the underside of the piston is

$$F = \frac{3}{4} \mu \pi L \left(\frac{D}{c}\right)^3 \tag{7}$$

and the damping factor f is

$$f = \frac{F}{V} = \frac{3}{4} \mu \pi L \left(\frac{D}{c}\right)^3 \tag{8}$$

It is significant that the damping factor varies inversely as the cube of the clearance, making it extremely sensitive to manufacturing variations. When a reasonably high damping factor is required a corresponding loss in precision damping must be expected since a 5 per cent variation in clearance will result in a 14 per cent change in damping factor.

No mechanical adjustment of damping is possible in this design after manufacture. This may be a serious drawback since the other characteristics of applications requiring pure viscous damping are rarely themselves known with great precision. Changing or mixing of oils to vary the damping is possible of course. When filling or changing oil, care should be taken that there are no trapped air bubbles below the piston which would alter the operation of the dashpot.

An adjustable dashpot is shown in Fig. 3. Here the piston fits tightly in the cylinder and motion forces the fluid around a passage and through a restriction (usually a needle valve).

Head losses through a valve are usually given in the form

$$h = k \frac{V^2}{2g} \tag{9}$$

where h is in feet of fluid, and k is the resistance coefficient of the valve. The resistance coefficient is roughly inversely proportional to the Reynold's number which brings viscosity, diameter and fluid velocity again into the picture.

$$k \approx \frac{1}{N_R} = \frac{\mu}{Vd\rho}$$

and substituting into equation (9)

$$h \approx \frac{\mu V}{2gd\rho} \tag{10}$$

This is only an approximate relationship and quantitative information will depend on the specific valve characteristics.

This type of dashpot is unsuitable for low damping factors or precise damping since the valve resistance coefficient is not strictly proportional to the inverse of the Reynold's number. This means that damping force is not a linear function of fluid speed and

$$f = \frac{F}{V}$$

is not constant for all speeds.

A more serious drawback arises through the need of a seal between piston and cylinder. Starting friction for this seal must be well below normal operating forces or the dashpot will not give even an approximation of viscous damping.

As outlined in the above two designs, damping is the same for either direction of motion. It is possible to make a drastic change in the damping factor by drilling holes in the piston and installing ball check or flapper valves as shown in Fig. 4. The flapper closes during the up stroke and damping proceeds normally. During the down stroke,

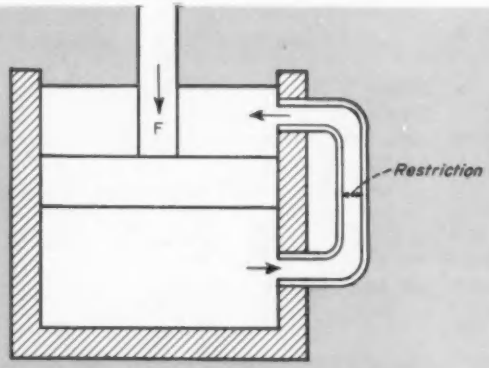


Fig. 3—Alternate linear dashpot damper with piston sealed against cylinder wall and fluid bypassed through valve or restriction.

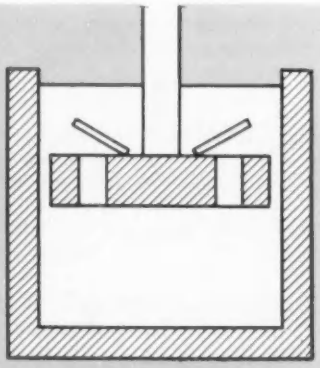


Fig. 4—Flapper valves in this dashpot piston provide differing damping characteristics for up and down motion.

however, the flapper opens increasing the area for oil flow and reducing the damping to a very low value.

ROTARY DASHPOTS

It is less easy to provide high damping factors on rotary dashpots since these do not operate on a pressure difference but on the direct viscous sliding of successive layers of fluid. The rotary damper is illustrated in Fig. 5, and it will be seen that with the cylinder held stationary and the piston rotated at a speed ω the fluid in the clearance between piston and cylinder takes a straight line velocity distribution. At the wall of the stationary cylinder the fluid velocity is zero. At the piston the fluid assumes the piston peripheral velocity

$$V_{max} = \frac{D}{2}\,\omega$$

and

$$\tau = \mu \frac{dv}{dx} = \mu \frac{D\omega}{2c} \tag{11}$$

where τ is the viscous drag on the surface of a cylinder of diameter D and length L. The total force of viscous drag is

$$F = \tau A = \mu\pi \frac{D^2\omega}{2c} L$$

and the viscous torque is

$$T = F \frac{D}{2} = \frac{1}{4}\,\mu\pi L\omega \frac{D^3}{c} \tag{12}$$

The viscous friction factor T/ω becomes

$$f = \frac{T}{\omega} = \frac{1}{4}\,\mu\pi L \frac{D^3}{c}$$

Note the similarity between this equation and that for the linear dashpot equation (8). The major difference here is that c is no longer a third power quantity, and to achieve a large value for the friction factor the clearance must be very small indeed if the overall diameter is not to become awkwardly large.

Some increase in damping may be achieved by bringing the side faces up close to faces of the piston as in Fig. 6. Neglecting the lost area where the piston rod enters, the viscous drag on the piston face may be expressed as

$$\tau = \mu r \frac{\omega}{c} \tag{14}$$

which is the same as equation (11) above except that the radius is now r which varies from zero at the axis to $D/2$ at the periphery of the piston.

The viscous force on any increment of area on the face of the piston is $\tau\, dA$ or

$$\tau dA = \mu r^2 \frac{\omega}{c}\, d\theta dr$$

which acts on a radius r to produce a viscous torque

$$dT = \tau r dA = \mu r^3 \frac{\omega}{c}\, d\theta dr$$

and integrating over the whole piston face

$$T = \int_0^{2\pi}\int_0^{\frac{D}{2}} \mu r^3 \frac{\omega}{c}\, dr d\theta$$

$$T = \frac{\mu\pi\omega}{8} \frac{D^4}{c} \tag{15}$$

Doubling this value to include top and bottom faces and adding it to the previous derived value for the outer periphery the new total becomes

$$f = \frac{T}{\omega} = \frac{1}{4} \frac{\mu\pi}{c} (LD^3 + D^4) \tag{16}$$

and if $L = D$

$$f = \frac{1}{2}\,\mu\pi \frac{D^4}{c} \tag{17}$$

effectively doubling the damping factor of a dashpot in which $L = D$ but only the peripheral clearance is used for damping.

EDITOR'S NOTE: A Reynolds Number Chart devised by George Loweke appeared in Product Engineering for April 1955, p. 213. This nomogram may be entered with values of viscosity, pipe diameter and velocity and Reynolds Number may be read out.

A convenient Viscosity Conversion Chart supplied by the Viking Pump Co. appeared in the Product Design Handbook issue for 1956, p. j10. Simple linear conversion is possible for any of the many viscosity units.

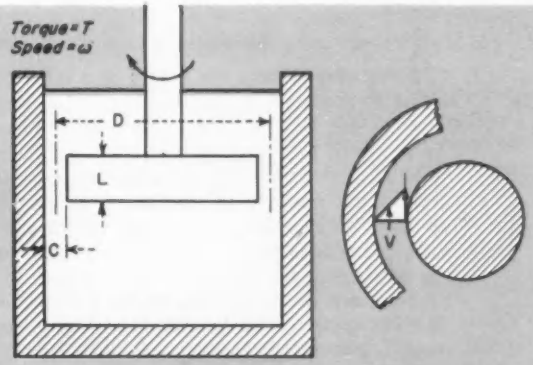


Fig. 5—Rotary damper depends for its action on sliding friction between successive layers of the fluid in the clearance between piston and cylinder.

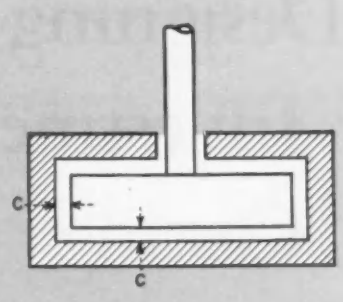


Fig. 6—By bringing the top and bottom surfaces into play considerable increase in damping factor is possible in an equal or smaller total volume.

Advantages and limitations of the method; tolerances obtainable, types of pattern materials and casting alloys; preparation of alloy specification, and inspection procedures.

Designing for Investment Casting

JOHN E. SRAWLEY, Director of Research,
Arwood Precision Casting Corp.

TO PROPERLY EVALUATE the investment casting technique it must be compared with sand, shell mold, plastic mold and die casting and even machined or built-up welded or brazed assemblies. Distinct differences in these methods help to determine which is the most suitable for a particular application.

Having chosen investment casting, proper foundry specifications for alloy, tolerances and inspection methods must be determined if all the advantages of this process are to be realized.

Advantages

Investment castings are formed in a refractory mold by pouring metal into cavities left by melting out wax patterns. Since molds do not have to be parted to remove patterns there is no need for the increased parting line tolerances required in shell and plaster mold castings. While parting surfaces are necessary in the wax pattern injection die, tolerances across the parting line need be no different from those in other directions.

No draft need be provided for removal of the wax pattern from its die, even when a deep draw is involved. Die castings can rarely be made without some draft on the die and sand castings require a minimum of 3 deg draft and must be rapped as they are withdrawn from the mold.

Finer surface finish and closer tolerances may be

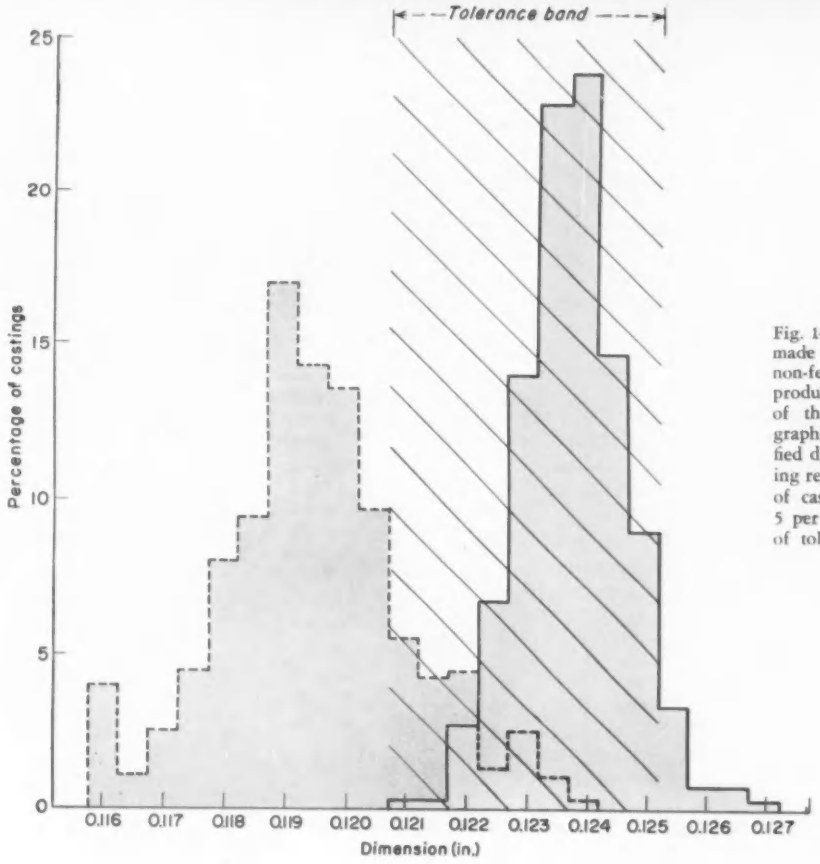


Fig. 1—Usual shrinkage allowance was made on the master patterns for this non-ferrous alloy casting. The initial production run was on the low side of the tolerance band (dotted line graph) and wide in variation. A modified die and closer control of the waxing resulted in a much improved group of castings (solid line graph). Only 5 per cent of these castings were out of tolerance.

achieved since mold material is applied to the wax pattern in the form of a slurry in which the coarse aggregate does not appear at the surface even though it forms a large part of the mix.

Greater complexity of design is possible with investment casting than with any other process. Conditions of service of dies for wax and plastic patterns are not severe and soluble cores, the preformed precision ceramic core, and expedients such as the assembly of several wax patterns into one by "wax-welding" add to its versatility.

Any castable alloy can be cast in an investment mold. Alloys which can only be machined with great difficulty and expense are readily cast, as are alloys too hot-short to be forged.

Investment casting may be cheaper than die casting in small quantities when high cost dies are considered. The relatively simple waxing dies are easily modified to incorporate design changes at much less expense than die-casting dies. When the design is finalized, production may be changed to the more economical die casting process.

Limitations

As compared with other methods investment casting usually involves more engineering design time and higher production labor cost. Skilled workers are required for the operations of waxing, gating, dip-coating, insertion in flask, investing, bake-out and firing of the mold even before the mold is ready to be cast.

To offset production cost it is possible to mechanize the investment casting process for quantity production. Three levels of service are ordinarily available; a pre-production or experimental line on which the initial engineering can be worked out and a procedure established to produce satisfactory parts in the most economical way; a short-run production line taking advantage of the flexibility of the human operation; and finally a high-production line using as many mechanical and automatic methods as are economically feasible.

Maximum dimensions are approximately 12 in. Larger sizes have been cast but at considerably increased cost of equipment and development.

Tolerances

Dimensional control is complicated by the need for accurate shrinkage estimating on the part of the designer of the wax or plastic die as shown in Fig. 1. Fortunately, experienced die designers are usually accurate in their predictions of how a casting will shrink. In addition, if dimensions are off when the regular production pattern material is used they may sometimes be corrected by using another wax or plastic with either greater or lesser shrinkage.

Engineering manuals generally follow the conservative rule of plus or minus 0.005 inches per inch for ferrous and high melting point alloys and plus or minus 0.003 in. per in. for non-ferrous alloys. For more detailed guidance it is necessary to study the reference works in this field.

Normal surface finish for investment cast surfaces is 125 micro-inches rms. Finishes as smooth as 30 micro-inches rms can be produced at much higher cost.

The Investment Casting Institute has set up a committee of representatives of industry and users of investment castings to draft a design manual. This will cover roundness, squareness and concentricity of holes and curved passages: airfoil and other contour tolerances; straightness, flatness, parallelism, squareness and positioning of holes and bosses, yokes, slots, angles as well as constant section dimensions.

Pattern Materials

Use of plastic rather than wax patterns can speed up the molding operation and significant savings are possible when the extra expense of dies for plastic molding can be justified. However, individual foundry methods are more significant in determining cost than the choice between wax or plastic patterns. Whether wax or plastic, patterns invariably show much less dimensional variation than the resultant castings.

Casting Alloys

Lack of recognized specifications hampers acceptability to the ultimate customer (often a government agency). Unsuitable material specifications, more appropriate to some previously used production method, can be misleading. Correspondence of composition does not guarantee that the cast material will have the properties of a similar wrought material. Further, the composition may make it difficult to produce sound castings.

Foundries should be allowed as much latitude as possible in the choice of material. Material specified on a drawing should be regarded as a preliminary indication of what is required rather than an immutable demand. Foundries will prefer to cast Aluminum 356-T6 (QQ-A-601a Class 3) to Aluminum 17S (QQ-A-3676 Class 1) or even B195, which cause difficulty in investment casting. Nickel-chrome steel 3120 is more easily cast than AISI/SAE 1020 and the higher material cost of 3120 is offset by the greater expectation of producing good castings.

Specification Practice

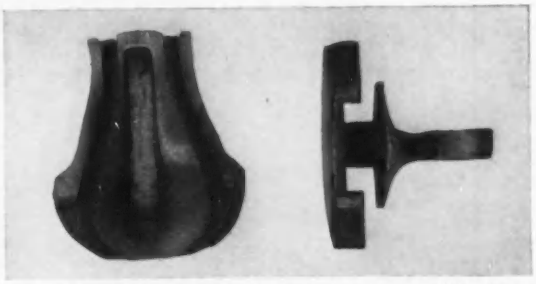
There are few specifications written to cover the requirements of materials for investment castings. Practices differ and may take one of the following alternate forms:

(1) Alloy may be designated on the drawing as a composition only, such as SAE 4140 or Aluminum 356, and additional requirements of heat treatment and physical properties added as drawing notes. Sometimes further information appears on the purchase order.

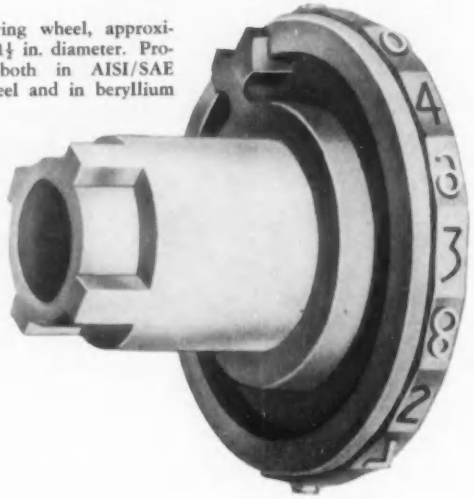
(2) User may write his own specification. This is common among the aircraft engine concerns and other large organizations.

(3) Foundry may have a specification for the material which is acceptable to the customer.

(4) Specification for the material in the form of castings other than investment castings may be available and acceptable with certain modifications. Usually the properties specified for sand, die or permanent mold cast test bars can be exceeded by the smaller investment cast bars.



Heavy duty zipper slider used on a popular convertible. These sliders are cast in strong, corrosion resistant alloys like manganese bronze and beryllium copper. Sliders for lighter duty are usually stamped or die cast in brass or zinc alloys.



Numbering wheel, approximately 1½ in. diameter. Produced both in AISI/SAE 4140 steel and in beryllium copper.

(5) Sometimes an attempt is made to specify material for investment castings by means of a wrought material specification (bar-stock, forgings, etc.). Although foundries may be prevailed upon to accept such specifications it is highly undesirable and unnecessary that they should do so. Apart from a general indication of the composition, there is little in a wrought material specification which has any relevance to castings.

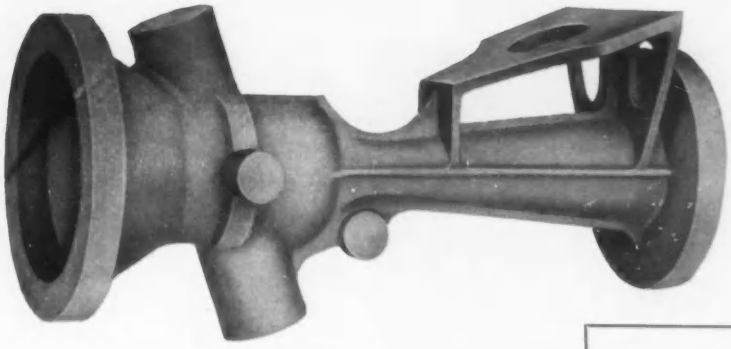
Wrought material specifications often contain requirements impossible to achieve with castings. This is particularly true of elongation and reduction of area values. However, properties of wrought material are specified in the as-rolled direction only. Properties in the transverse directions are frequently inferior to those of the same material when cast.

Ultimate and yield strength values of wrought material specifications are usually readily attainable in the cast material (wrought material here refers to hot-rolled or forged material and not to cold-worked material). Since these values are used directly in design, castings can be substituted for wrought materials with confidence.

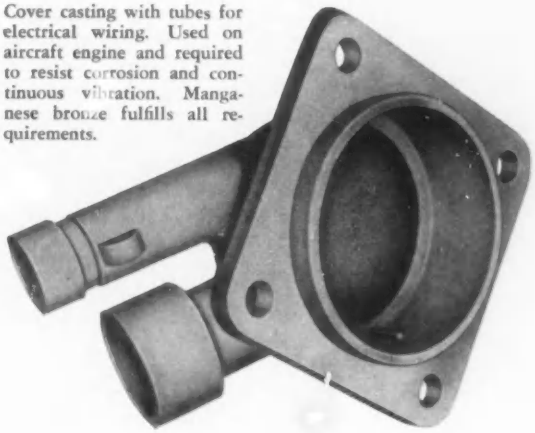
Alloy Specifications

It is always best to make use of an investment casting specification. Those presently available are as follows:

(1) Various Aeronautical Material Specifications issued



Stainless steel aircraft engine valve body. Material is AISI type 347 (AMS 5362); overall dimension 8 x 4 x 3½ in. Subject to 100 psi proof test. Illustrates shape obtainable by investment casting; tolerances and sections preclude sand casting.



Cover casting with tubes for electrical wiring. Used on aircraft engine and required to resist corrosion and continuous vibration. Manganese bronze fulfills all requirements.

Vacuum Melting

VACUUM MELTING AND CASTING has moved out of the laboratory and into very limited production. Since cost is the limiting factor, various compromises are being tried to obtain the advantages of vacuum treatment without incurring the full cost of melting and casting in a vacuum. Such compromises include the use of vacuum melted ingot for melting stock and the application of vacuum to crucibles to remove gases before pouring.

Vacuum melting is beneficial to all alloys except those containing vital constituents which are volatile under vacuum. No other process is so effective in controlling hydrogen, oxygen and nitrogen gases. It insures a clean melt, relatively free from slag and dross due to reaction of the melt with the atmosphere.

If the whole operation of melting and casting is carried out under vacuum, as contrasted with the more common procedure of applying vacuum to the bottom of the mold during pouring, the common difficulties associated with air entrapped in the mold cavities and entrained by the metal stream are avoided. However, atmospheric pressure during solidification often contributes to casting soundness.

by the AMS Committee of the SAE. These cover some stainless steels, one or two low alloy steels, a number of high temperature alloys, aluminum 356-T6 and (in preparation beryllium copper 20CR.

(2) An SAE recommended practice for investment casting covering a number of carbon and low alloy steels. This is written to allow the foundry latitude in the choice of composition while insuring certain minimum properties and will serve adequately for nearly all specification purposes within its scope.

(3) Two Military specifications, MIL-C-11866 (ORD) for non-ferrous and MIL-C-10005 (ORD) for ferrous castings. These do not refer to any specific alloys or properties, but are meant to be used in conjunction with instruction notes on the drawing or in the contract.

(4) MIL-C-17324 (BUORD) covering a beryllium copper composition which, however, does not correspond with the widely used casting compositions.

A committee of the Investment Castings Institute is now engaged in the preparation of a complete set of specifications under the auspices of the Institute.

Inspection

Most investment foundries have a wide range of inspection equipment. In addition to instruments, gages and fixtures more common to a toolroom than the average foundry there may be a chemical laboratory, equipment for mechanical and hardness testing, and facilities for radiography, magnetic particle and fluorescent penetrant inspection.

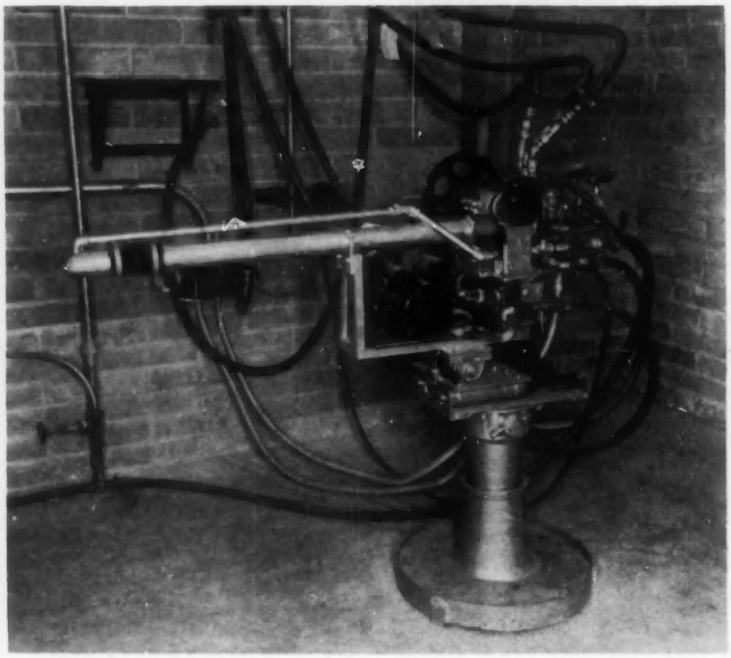
Initial castings from every new die receive a full dimensional layout inspection and are radiographed and perhaps inspected for surface defects by magnetic or penetrant methods. Once a satisfactory method of gating the part and a foundry procedure have been established, production parts will be inspected according to the requirements of the customer. Price will depend to some extent on severity and number of inspection requirements.

EDITOR'S NOTE—Earlier Articles in *Product Engineering*

A similar process using frozen mercury instead of wax is described in "Frozen Mercury Process for Investment Castings," in the 1956 Product Design Handbook page D-13. Also investment casting is compared to five other casting processes in "Evaluation of Casting Processes," March 1954 page 139.

Extension of the process to parts of 35 lb or larger was noted in "Investment Castings: They're Getting Bigger," April 1953 page 137; types of patterns, part design and special development problems associated with larger sizes.

Basic article on the precision casting process, "Investment Casting: Alloy Selection and Design," November 1951 page 184, presents factors in selecting the alloy; specific design suggestions cover changes in section, core design, bosses and ribs. A three-page table starting on page 203 gives castability rating, properties and applications for 30 materials.



LINDE'S FLAME-PLATING GUN consists of a barrel, plus a mechanism for loading quantities of oxygen, acetylene, and tungsten carbide powder into the firing chamber. The plating material consists of tungsten, carbon, and 8 per cent cobalt. The gun is aimed and fired by remote control from a central board outside the firing chamber. The gun will not be exhibited at the Show; plated parts however, will be on display.

Latest in Product Development At Design Show

NEXT MONTH REPRESENTATIVES OF the $30-billion original equipment market will be exhibiting their products at the one show that has been planned for this particular field. Called the Design Engineering Show, it is the first of its kind, and will be held in Philadelphia's Convention Hall, May 14th to 17th. To date, 175 companies have reserved booths at the show. By show time it is expected that this number will have increased to 200.

From the standpoint of attendance, this show is a natural for the design engineer; in fact, it has been arranged for him, for it is a well known fact that a designer must visit a variety of shows to see the latest developments in his field. Now, at one show, there will be on display the many mechanical components, power and control devices, materials, types of finishes, and the latest production and processing methods which the engineer will be specifying for his new design.

An example of this is shown in the illustration above. This is the Flame Plating Gun developed by Linde Air Products Co., Division of Union Carbide and Carbon Corp. "Controlled Detonation," according to Linde, is the key to the process. Particles of tungsten carbide (presently the only material which is being commercially flame-plated) are fed into the chamber of the gun and are suspended in a mixture of oxygen and acetylene. When this mixture is ignited, a detonation takes place. The heat wave that is built up travels at about 10 times the speed of sound, passes through the tungsten carbide particles, heats them to the point of plasticity, and at the same time greatly increases their velocity.

When these particles hit the piece to be plated, a welding action takes place, producing a strong bond. Although the temperature inside the barrel of the gun reaches 6000 F, the temperature of the part being plated rarely exceeds 400 F. Additional detonations build up the coating material to the desired 0.002 to 0.010 in. thickness.

After flame-plating, the surface of the part is like fine emery paper. Hardness of the coating is about 1350 Vickers Pyramid Number, which is equivalent to about 89.3 Rockwell A. The modulus of elasticity of the flame-plated part is 27,000,000 psi, as compared to 64-92,000,000 psi for sintered tungsten carbide. Porosity of the coating is less than 0.5 per cent. In thermal shock tests, flame-plated steel strips were loaded in tension to 15,000 psi, heated to 1350 F in 45 sec, and cooled to 120 F in 30 sec. A 0.010 in. coating failed after six cycles of heating and cooling; a 0.005 in. coating started to fail after 200 cycles; and a 0.002 in. coating was unaffected after 500 cycles.

Linde will not have the flame plating gun at the Design Engineering Show, but will have on display a variety of different parts that have been plated. Some of these are: plug and ring gages; turbine engine seals; core rods; cold forming dies; ball piston pump bushings; feed and gripping dogs; aluminum rocker arms; anvil blocks; wire forming mandrels and others. Linde does not plan to sell the flame plating guns, but will do the plating as a service.

This is just one of the many new developments, and one of the many leading companies that will have exhibits at the Design Engineering Show.

Besides the show, a series of conferences has been arranged by the Machine Design Div. of the ASME. The chief editors of the magazines *Product Engineering*, *Machine Design*, *Materials & Methods*, and *Electrical Manufacturing* have been appointed as papers committee. The titles of these papers are: "Value Analysis in Product Design;" "How to Get and Train Design Engineers," (a 3-man panel discussion); "Selecting Engineering Materials;" "Problems of Miniaturization;" "Recognition and Reward for Invention;" and "Rights of the Employee's Invention."

Where computational labor makes normal curve fitting technique laborious this method offers a short cut by use of reference tables and a computation chart which can be followed by any calculating machine operator

Curve Fitting with Orthogonal Polynomials

CHARLES R. SEXTON, Walnut Creek, Calif.

a, b, c, d, a_m	polynomial parameters
D	differential pairs of y_i values
i	sequence of given set of data points ($i = 1, 2, 3, 4, \ldots n$)
p_1, p_2, p_3, p_m	orthogonal polynomials in x
n	number of given data points
r, s, m	degree of polynomial p_r, p_s, p_m
R	sum of squares of residuals
S	summed pairs of y_i values
x, X	independent variables of fitting curve
x_i	abscissae of given data points
y	dependent variable of fitting curve
y_i	ordinates of given data points
λ	"common factor"

At one time or another, most engineers have fitted a straight line, parabola, or possibly a higher degree polynomial to a given set of data by the method of least squares. This method specifies that the best fit for a polynomial of given degree results when R, the sum of the squares of the residuals, is a minimum. It is assumed that values of x_i the independent variable, is error-free, and the residuals are defined as the distances between observed y_i's and the corresponding y values of the curve being fitted, measured parallel to the y-axis.

To determine the parameters (constants) of the desired polynomial a set of "normal" equations is derived by a squaring and minimizing process. If a polynomial of best fit of a given degree is to be found for a set of n data points, then

$$R = \sum_{i=1}^{i=n} (y - y_i)^2 = \text{minimum}$$

where

$$y = f(x) = a + bx + cx^2 + \ldots$$

If $f(x)$ is a straight line, $y = a + bx$. The ordinates of the straight line being fitted are $a + bx_i$ and the summation becomes

$$R = \sum_{i=1}^{i=n} (a + bx_i - y_i)^2$$

Taking derivatives with respect to the parameters a and b, and setting the derivatives equal to zero

$$\frac{\partial R}{\partial a} = 2 \sum_{i=1}^{i=n} (a + bx_i - y_i) = 0$$

$$\frac{\partial R}{\partial b} = 2 \sum_{i=1}^{i=n} x_i (a + bx_i - y_i) = 0$$

from which

$$\sum_{i=1}^{i=n} y_i = an + b\sum_{i=1}^{i=n} x_i$$

$$\sum_{i=1}^{i=n} x_i y_i = a\sum_{i=1}^{i=n} x_i + b\sum_{i=1}^{i=n} (x_i)^2 \qquad (1)$$

Solution of these two simultaneous linear equations gives the values of a and b, parameters of the equation $y = a + bx$, the straight line that best fits the given data points by the criterion of least squares.

It is evident that as the degree of the desired equation goes higher so does the number of parameters to be derived.

By putting the origin of x at the center of the given data, summations of odd powers of x equal zero and summations of even powers of x can be obtained by using tables or formulae. This simplifies the solution somewhat, but for a fourth degree equation a pair of simultaneous equations in two unknowns as well as a set of three equations in three unknowns still remain to be solved. At best the calculation of parameters and residuals is cumbersome when one attempts to rapidly test the fit of a series of polynomials of various degrees by the use of normal equations.

Orthogonal Polynomial Theory

Tables of orthogonal polynomials offer a relatively simple method of computation and a desk calculator having accumulative multiplication will swiftly handle the main bulk of calculation. It should be noted that unless the values of x are evenly spaced, or can be made so, tables of orthogonal polynomials cannot be used.

In the development of normal equations, a polynomial

$$y = a + bx + cx^2 + dx^3 + \ldots \qquad (2)$$

is fitted to the set of data. When orthogonal polynomials are used, the procedure is to express y in terms of

Table I—Example of Orthogonal Polynomials

$p_1 = x - 4$, $p_2 = x^2 - 8x + 12$ $(n = 7)$

x	p_1	p_2	$p_1 p_2$	p_1^2	p_2^2
1	−3	5	−15	9	25
2	−2	0	0	4	0
3	−1	−3	3	1	9
4	0	−4	0	0	16
5	1	−3	−3	1	9
6	2	0	0	4	0
7	3	5	15	9	25
Total (Σ)	0	0	0	28	84

orthogonal polynomials of x

$$y = a_0 + a_1 p_1 + a_2 p_2 + a_3 p_3 + \ldots \qquad (3)$$

where the various p's are polynomials in x, each to the degree of the indicated subscript, and a_0, a_1, a_2 are new constants. For example, p_1 might be $x - 4$ and p_2 might be $x^2 - 8x + 12$ (Table I).

Polynomials orthogonal to each other over a given set of n values of x have the following properties:

$$\sum_{x=1}^{x=n} p_r p_s = 0; \quad \sum_{x=1}^{x=n} p_r^2 \neq 0;$$

and $$\sum_{x=1}^{x=n} p_s^2 \neq 0;$$

where r and s $(r \neq s)$ indicate the degree of each polynomial; also

$$\sum_{x=1}^{x=n} p_m = 0$$

for an orthogonal polynomial of any degree m.

Over the range $x = 1$ to $x = 7$, the polynomials $p_1 = x - 4$ and $p_2 = x^2 - 8x + 12$ are orthogonal to each other, as can be seen in Table I $(n = 7$ points).

When the squaring and minimizing process previously illustrated is employed with orthogonal polynomials, cross products such as $a_r a_s \Sigma p_r p_s$ $(r \neq s)$ and $a_0 a_1 \Sigma p_1$ drop out. The result is that each coefficient in Eq (3) is found independently of the others, eliminating the necessity of solving simultaneous equations.

$$a_0 = \frac{\Sigma y_i}{n}$$

$$a_1 = \frac{\Sigma y_i p_1}{\Sigma p_1^2} \qquad (4)$$

$$a_2 = \frac{\Sigma y_i p_2}{\Sigma p_2^2}$$

Over the given range of data $(x_i, y_i)_1^n$ using tables of orthogonal polynomials, the constants a_0, a_1, etc., can be calculated, sums of squares of residuals computed, and the ordinates of each degree's least-square curve of best fit determined. In order to plot each of these curves of best fit (within x-limits of given data) it is not necessary to determine the equation of the curve.

Use of Tables

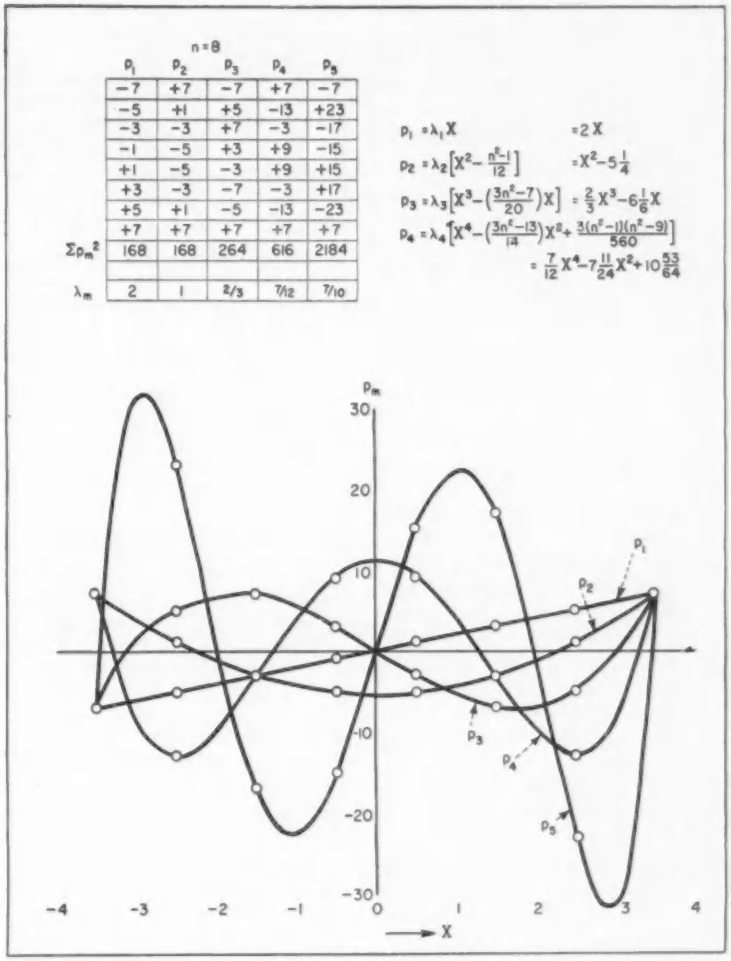
Tabulated orthogonal polynomials are listed by the number of data points they cover. The tabulated polynomials are usually carried to at least the fifth and, in some tables, to higher degrees.

The numbers which appear in the tables represent the value of the polynomial at the particular data point in question. As shown in Fig. 1, each column is actually a set of values of each polynomial over the range of data points. Note that in the graph the points are plotted symmetrically around the p_m axis and a new inde-

Table II—Details of Tables of Orthogonal Polynomials More Commonly Available

Author	Title	Publisher	Range of Number of Data Points (n) to which Curves may be Fitted	Highest degree of Polynomial (generally) which may be Fitted	Portion of Tables Generally Included	Symbol Used Corresponding to p_1, p_2, p_3, p_m in this Article	Symbol Used for Common Factor	Text, Explanatory Material Theory, etc. Generally Considered
Anderson, R. L. Houseman, E. E.	Orthogonal Polynomial Values Extended to $N = 104$	Research Bulletin No. 297—Iowa State College, Ames, Iowa	3–104	5	Lower Half	ϵ'	λ	Very Good
Pearson, E. S. Hartley, H. O.	Biometrika Tables (pages 91, 212)	Cambridge University Press, 32 E. 37th St. New York 22, N. Y.	3–52	6	Upper Half	ϕ	λ	Good
Birge, R. T. Weinberg, J. W.	Least Squares Fitting Polynomials	Reviews of Modern Physics V. 19, No. 4 p. 298–360, October 1947	3–30	5	Lower Half but REVERSE order	V	λ	Technical
De Lury, D. B.	Table of Orthogonal Polynomials	University of Toronto Press, Toronto, Canada	3–26	1 to $(n - 1)$	Lower Half	ϵ'	No common factor given	Technical
Fisher, R. T. Yates, F.	Statistical Tables for Biological, etc. Research (1953 ed.)	Oliver and Boyd 98 Great Russell St. WC London, England	3–75	5	Lower Half	ϵ'	λ	Good
Van Der Reyden, D.	Curve Fitting Orthogonal Polynomials	Onderstepoort Journal of Vet. Science and Animal Industry (South Africa) Vol. 18, Nos. 1 and 2, July–Oct. 1943	5–32	9	Upper Half	ϕ	λ	Excellent

Fig. 1—Tabulated orthogonal polynomials ordinarily do not include half of the complete set of values (for larger values of *n*) since symmetry permits their easy determination. At the right are the formulae of the explicit expressions of these polynomials in terms of *X*. The values listed in the table are plotted below to graphically demonstrate symmetry.



pendent variable $X = x - 4\frac{1}{2}$ is used. The "common factor" λ_m and the equations to the right of the tabulated data serve to derive the explicit functions p_1, p_2, etc. In one table (DeLury) the factor λ_m is not given, however, it can be determined by substituting one tabled value of p_m, its corresponding value of X and the appropriate n using the formulae of Fig. 1.

It is interesting (and valuable) to note the symmetry in the curves and tabulated values of p_m as shown in Fig. 1. Even degree polynomials (p_2, p_4) are mirror images about the p_m axis, odd degree polynomials are mirror images with a reversal of sign. Such symmetry permits a considerable reduction in computation time as demonstrated in the illustrative problem.

A word of caution is in order regarding the use of the various tables of orthogonal polynomials. The authors in Table II do not use the symbol p for the tabled polynomials, nor do all authors include the common

Table III—Illustrative Problem

Column Number																						
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
				D	S	a_0	p_1	p_1D	a_1p_1	y	p_2	p_2S	a_2p_2	y	p_3	p_3D	a_3p_3	y	p_4	p_4S	a_4p_4	y
Original Data		y_i Folded back																				
x_i	y_i			(3) − (4)	(3) + (4)	$\frac{\Sigma y_i}{8}$		(5) × (8)	$a_1 = -0.5$ (7) + (10)		(6) × (12)		$a_2 = -8.214$ (11) + (14)			(5) × (16)	$a_3 = 10.5$ (15) + (18)			(6) × (20)	$a_4 = 1.714$ (19) + (22)	
1	−140	−140	0	−140	−140	−24.5	−7	980	3.5	−21	7	−980	−57.5	−78.5	−7	980	−73.5	−152.0	7	−980	12.0	−140
2	0	0	−110	110	−110	−24.5	−5	−550	2.5	−22	1	−110	− 8.2	−30.2	5	550	52.5	22.3	−13	1430	−22.3	0
3	70	70	− 80	150	− 10	−24.5	−3	−450	1.5	−23	−3	30	24.6	1.6	7	1050	73.5	75.1	−3	30	− 5.1	70
4	64	64	0	64	64	−24.5	−1	− 64	0.5	−24	−5	−320	41.1	17.1	3	192	31.5	48.6	9	576	15.4	64
5	0					−24.5			−0.5	−25			41.1	16.1			−31.5	−15.4			15.4	0
6	−80					−24.5			−1.5	−26			24.6	− 1.4			−73.5	−74.9			− 5.1	−80
7	−110					−24.5	Computations not needed		−2.5	−27	Computations not needed		− 8.2	−35.2	Computations not needed		−52.5	−87.7	Computations not needed		−22.3	−110
8	0					−24.5			−3.5	−28			−57.5	−85.5			73.5	−12.0			12.0	0
Totals	−196							− 84				−1380				2772				1056		

factor λ_m (or the same λ_m). Some of the introductory matter of the various tables is simple and easily followed, others may be more confusing than helpful. Descriptive matter concerning the available tables is given in Table II.

Illustrative Problem

By the method of least squares, using tables of orthogonal polynomials, determine for the x_i, y_i data values ($n = 8$) given in Table III, columns 1 and 2 the best fitting straight line, second degree parabola, etc., and calculate each analytic expression $y = f(x)$.

Because of symmetry of the orthogonal polynomials, the y_i values can be rearranged as in columns 3 and 4, being written so that the beginning and ending values (−140 and 0) are paired at the top of columns 3 and 4. This procedure will take advantage of symmetry, as described below, to reduce computational labor. If there happens to be an odd number of data points, the mid-point value of y_i can stand alone in either of columns 3 or 4, and the process will automatically work out properly.

Next, the difference (D) of the paired y_i values is copied into column 5, and the sum (S) into column 6. The mean or average of all y_i values is then copied into every row of column 7. Then, referring to tables of orthogonal polynomials (or Fig. 1), the values of p_1, p_2, p_3, etc. are copied into columns 8, 12, 16, 20, respectively.

To determine the constants a_1, a_2, a_3, etc., $\Sigma y_i p_m$ must first be computed. Each pair of values may be multiplied and then a sum taken, but a shortcut is possible here because of symmetry using the "doubled-up" arrangement of columns 3 and 4. Values of p_1D, p_2S, p_3D, p_4S are calculated. The odd degree polynomials are symmetrical with reversed signs so these multiply the differences (D) in the y_i values. Even degree polynomials are perfectly symmetrical so these multiply the sums (S) of the y_i values. In this way only half the multiplications are required for determining the $\Sigma y_i p_m$. The various products are listed in columns 9, 13, 17 and 21 in Table III and totaled. Where positive and negative accumulative multiplication is available it is not necessary to record any products in these columns.

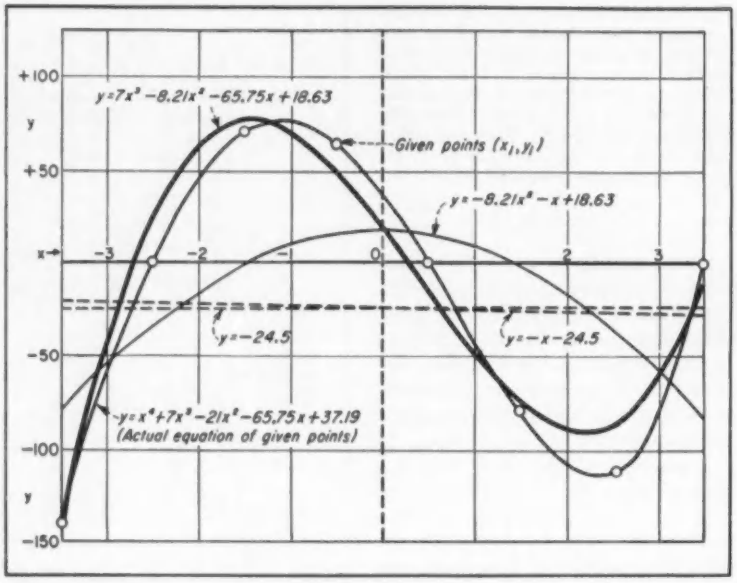


Fig. 2—Illustrative Problem. Circled points are the given data. The data has been plotted symmetrically about the y axis and X varies from −3.5 to+3.5. As each succeeding orthogonal component of higher degree is added a better fit to the given data is achieved.

Sums of squares of p_1, p_2, p_3, etc. are listed in Fig. 1. These may be found in all tables. The constants a_1, a_2, a_3, etc., are calculated as $a_m = \Sigma y_i p_m / p_m^2$. Each constant computed in Table V and entered at the tops of columns 10, 14, 18 and 22 of Table III. Having determined the constants a_0, a_1, a_2, etc., an analytic expression for y, if needed for extrapolation or other purposes, may now be written as outlined in Table IV using formulae (good for any value of n) of Fig. 1. However, if a plot of the computed least squares curve (or curves of all degrees) is desired rather than their analytic expressions only two more quick steps on the prepared computation sheet (Table III) are needed.

The products $a_m p_m$ are computed and entered in columns 10, 14, 18 and 22. Note that symmetry provides the lower four values exactly reversed in order for the even degrees and reversed and opposite in sign for the odd de-

Table IV—Derivation of Analytical Expressions

Degree Polynomial of Best Fit	From Equation (3)	From Equation (5)	Derivation of Equation (6) where $X = x - 4.5$
	a_0	− 24.5	− 24.50
	$a_1 p_1$	− 0.5 p_1	$- X$
1	Straight Line		− 24.50 $- X$
	$a_2 p_2$	− 8.214 p_2	43.13 $- 8.21 X^2$
2	Parabola		18.63 $- X - 8.21 X^2$
	$a_3 p_3$	+ 10.5 p_3	$- 64.75 X + 7 X^3$
3	Cubic		18.63 $- 65.75 X - 8.21 X^2 + 7 X^3$
	$a_4 p_4$	+ 1.714 p_4	18.56 $- 12.79 X^2 + X^4$
4	Quartic		37.19 $- 65.75 X - 21.00 X^2 + 7 X^3 + X^4$

Table V—Sums of Squares of Residuals

(1)	(2)	(3)	(4)	(5)	(6)
Degree m of Orthogonal Component Being Fitted	Total p_1D, p_2S, p_3D, etc. (from Table III)	Σp^2_m (from Tables)	$a_m = \frac{(2)}{(3)}$	Reduction in Sums of Squares of Residuals (2) × (4)	Value of R for Best-Fitting Curve of Degree m
0	− 196	8	−24.500	4,802	42,294
1	− 84	168	− 0.500	42	42,252
2	−1,380	168	− 8.214	11,336	30,916
3	2,772	264	10.500	29,106	1,810
4	1,056	616	1.714	1,810	0
				Total = 47,096	
				Σy_i^2 = 47,096	

grees. Columns 11, 15, 19 and 23 contain the computed values of the ordinates of the least-squares curves (degree 1 to 4) of best fit for each value of x_i. Each ordinate value is obtained by adding on an orthogonal component to the ordinate of the least-squares curves of one degree lower. As each succeeding degree polynomial is added, a better fit to the given data results as shown in Fig. 2. The process of simple addition across Table III illustrates the important point: when polynomials of higher degree are calculated, all previous work done for the lower degree is retained and used. This principle is also demonstrated in Table IV.

Columns can be provided to the right of column 23 and used for testing fifth and higher degree polynomials. For the example shown $\Sigma y_i p_5$ etc. are zero since a fourth degree curve exactly fits the given data points.

Determination of sum of squares of residuals for each successively determined polynomial is illustrated in Table V. The sum of squares of the original data values is 47,096. As each higher degree polynomial is added this sum of squares of residuals is reduced by an amount computed in column 5 of Table V. The sum of these reductions through the fourth degree polynomial is equal to the sum of squares of the original data, indicating a perfect fit.

In practice a perfect fit will rarely be reached and the sum of squares (Table V, Col. 6) will not quite be reduced to zero. The computation forms (Tables III and V) should be carried to the degree at which the next succeeding degree of polynomial results in practically no reduction in the sums of squares. However, it is generally so easy to make the computation that the author recommends testing through several higher degrees.

Written in orthogonal polynomial form, the equation developed in Table III is

$$y = -24.5 - 0.5p_1 - 8.2p_2 + 10.5p_3 + 1.7p_4 \qquad (5)$$

To reduce this to an equation which is in X, the expressions for the various polynomials in terms of X must be derived. Fig. 1 lists these expressions and the formulae upon which they are based. (For formula for p_5 see Anderson & Houseman, p 498; for p_5 and higher degrees see Birge and Weinberg, p 307.)

Substituting the relations of Fig. 1 into Eq (5) results in

$$y = 37.19 - 65.75X - 21X^2 + 7X^3 + X^4$$

A simple method of substitution is shown in Table IV. However, the independent variable X used here and in Fig. 1 represents a side shift to center the data. Where this is inconvenient, a substitution $X = (x - 4.5)$ may be made, which gives an equation in terms of x.

When this is done the explicit function equation of the curve of best fit is

$$y = x^4 - 11x^3 + 6x^2 + 184x - 320$$

When an equation in X is transformed into one in x, or vice versa, the use of synthetic division will prove helpful in carrying out the operation, or for checking purposes (see Uspensky, J. V. Theory of Equations, McGraw-Hill, p 44).

Summary

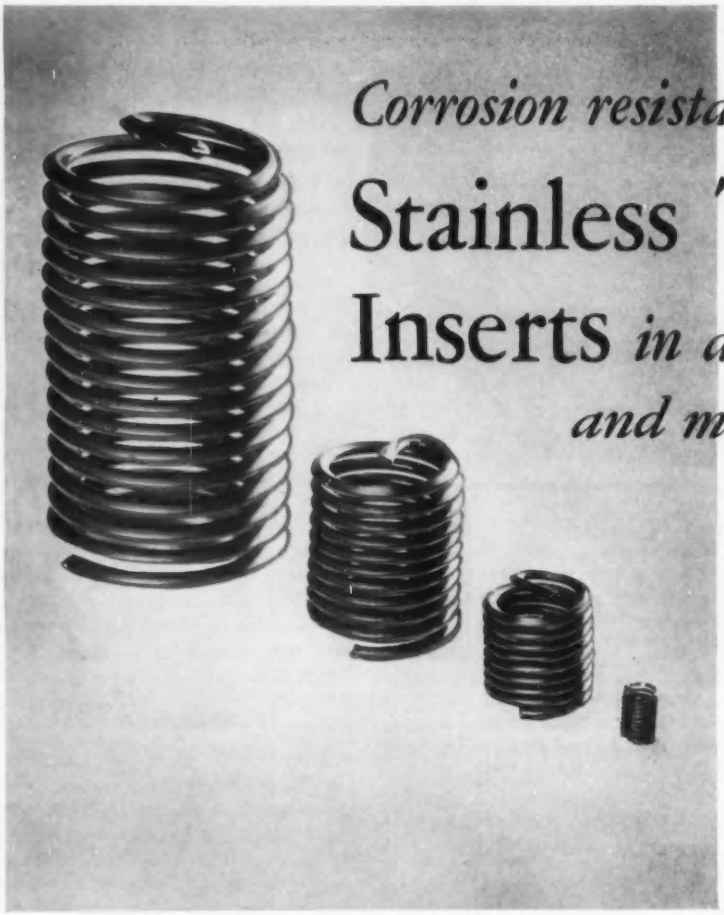
Curve fitting by the use of tables of orthogonal polynomials offers great advantages to engineers and other scientific workers who will take the time to work out an illustrative problem such as the above. Engineers who have worked with the fitting of Fourier series (harmonic analysis) will notice a similarity between these and Fourier methods. In fact, the fitting of such trigonometric series also involves the same concept of orthogonality.

EDITOR'S NOTE: Mathematical definition of the more complex surface shapes, like those of aircraft fuselage components, has been simplified into a single curvature approach in which the surface is built up from segments of cones. A step by step description of this approach is given in "Single Curvature Technique Speeds Body Profiling," G. M. Kelley, August 1954, p. 135.

To assist in the machining operations which produce curved surfaces from two cylinders or cones of revolution, a mathematical approach will be derived and sample calculations included for the application of "Surface Curvature," by Ernest Wildhaber, coming in May 1956.

Mathematical shape analysis has always had considerable application in the dynamics of cams and their followers. For applications having neither high speeds nor forces, parabolic or gravity cams may be used. "Nomogram for Parabolic Cam with Radially Moving Follower" by Rudolph Gruenberg appeared in Product Engineering, January 1955, p. 209.

A series of three articles devoted to "Plate Cam Design," by M. Kloomok and R. V. Muffley were published in Product Engineering last year. The first in February, 1955, p. 156, included complete design data with tables, charts and graphs to facilitate the selection and blending of profile curves. The second, in May, 1955, p. 155, covered the determination of maximum pressure angles with a comprehensive set of charts developed with the help of automatic computing equipment. The third in this series in September, 1955, p. 186, studied minimum radius of curvature which must be calculated to prevent undercutting and to keep surface stress within allowable limits.



Corrosion resistance of Stainless Thread Inserts *in aluminum and magnesium alloys*

Extensive salt-spray tests show that no finish is needed on the insert; various finishes for flange and washer are evaluated for blind and through holes with and without bolts inserted; design suggestions for finish specifications.

PAUL E. WOLFE, Director of Project Engineering, Heli-Coil Corporation

STAINLESS STEEL THREAD INSERTS of the type shown above are now approved for aircraft use, and design standards have been prepared by several leading manufacturers based on Military Standards MS 122116-122-275 (OASG), MS 124651-124850 (ASG), and MS 33537-(ASG).

Although the increased thread strength made possible by these inserts is generally appreciated, some users are concerned that some galvanic corrosion will take place when a stainless steel member is installed in a magnesium or aluminum casting. Because of this, detailed specifications have been written for cadmium or zinc plating of inserts plus the use of anti-corrosion compounds. Tests and field experience, however, show that cadmium plating materially affects Class 2, 3B and 3 tolerances, and fits are difficult to maintain.

To determine the degree of corrosion that could be expected under severe conditions, and to assess the effectiveness of protective plating, and anti-corrosive treatment, salt spray tests covered by Federal Specification QQ-M-151a were conducted on C-T6 magnesium and 356-T6 aluminum alloys. "Blind" and "through" holes were drilled and tapped in 21 test specimens. Stainless steel wire thread inserts in sizes ¼-28 x ½ in., 10-32 x 0.380 in. and ⅜-24 x ⅝ in. were installed. Cadmium-plated aircraft quality carbon steel AN bolts were selected at random and assembled in the inserts. Some holes were fitted with inserts but without bolts. Specimens with bolts were torqued to values specified in USAF "Handbook of Instructions for Aircraft Designers."

Magnesium test specimens were subjected to 200 hrs of salt spray tests and the aluminum test specimens to 500 hrs of salt spray tests (Specification QQ-M-151a).

Test variables included flange and parent materials, washer materials and surface protection. Coatings on some parts were applied before installing inserts, on others, coating was applied after the insert. Similarly, zinc chro-

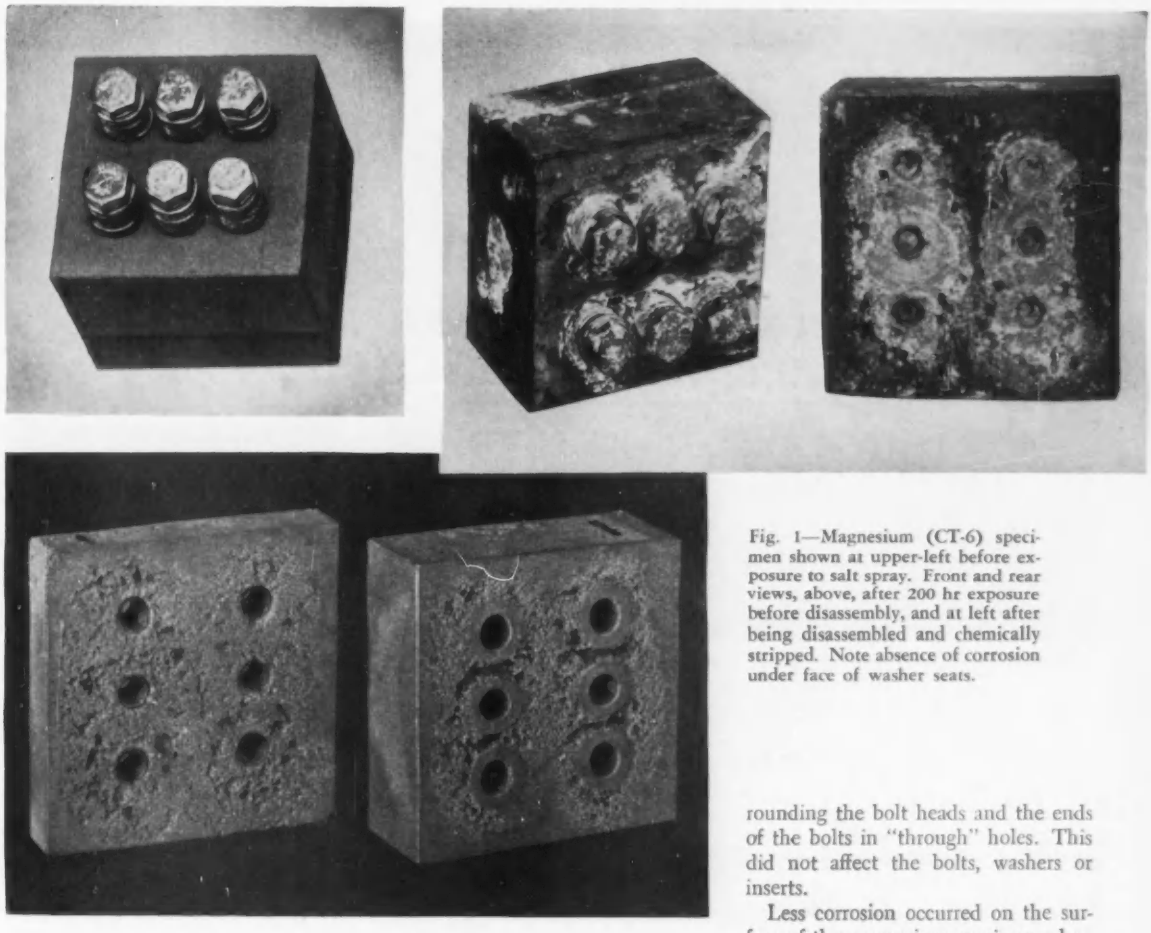


Fig. 1—Magnesium (CT-6) specimen shown at upper-left before exposure to salt spray. Front and rear views, above, after 200 hr exposure before disassembly, and at left after being disassembled and chemically stripped. Note absence of corrosion under face of washer seats.

mate primer was applied before the insert, after the insert, and some parts had no zinc chromate primer. Some aluminum specimens were anodized per AN-QQ-A 696a, others were given a chemical treatment. Iridite 14 and 14-2, plus two coats of finishing primer then two coats of aircraft lacquer were added. Some magnesium parts were treated with Iridite 15 and others, a dichromate treatment as per Specification MIL-M-3171, Type III, plus two coats of primer, per MIL-P-6889A, type I and two coats of aircraft lacquer per MIL-L-7178.

Test Results

As illustrated in Fig. 1, no corrosive action was detected on either insert or threads when assembled with bolts in magnesium specimens. This was true for both blind and through holes.

When bolts were omitted, crests (minor diameter) of tapped holes corroded to varying degrees depending upon the surface protection. No corrosion was noted on holes treated with Iridite 15, or with dichromate solution, as shown at right in Fig. 2(A). Whether the dichromate was applied before or after the insert was installed made no detectable improvement. Also, there was no significant difference between the Iridite and dichromate treated parts and no apparent advantage to using a zinc chromate primer with either of these coatings.

No dimensional changes were noted on minor diameters or pitch diameters of tapped holes as a result of using Iridite 15 or dichromate, before or after the inserts were installed. However, there was some surface corrosion on the specimens which was largely confined to the areas immediately surrounding the bolt heads and the ends of the bolts in "through" holes. This did not affect the bolts, washers or inserts.

Less corrosion occurred on the surface of the magnesium specimen when cadmium plated, carbon steel washers were used than with 24S clad aluminum washers. When inserts were exposed at the ends of "through" holes, they caused no more galvanic corrosion than would have been caused by the ends of the bolts.

With the aluminum specimens, Fig. 3, there were no signs of corrosion either on external surfaces, internal surfaces, or tapped holes into which the stainless steel inserts were installed. These conclusions were based on 500-hr salt spray tests.

These data, supported by test results from Douglas Aircraft Company and Boeing Airplane Company (see box on next page), show that it is not necessary to cadmium plate stainless steel inserts that will be assembled in aluminum and magnesium parts. This is probably a result of the following:

1.–Insert is hard (Rc 43-50), and has a surface finish equivalent to at least a ground finish (8-15 μ in.).

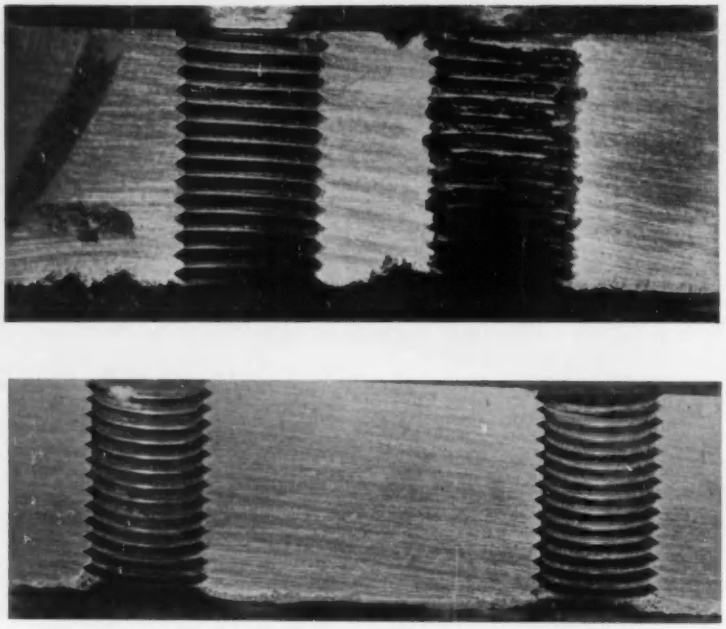


Fig. 2—Condition of internal threads in magnesium parts after inserts were removed. Top specimen was given Iridite 15 surface treatment. Insert but no bolt was used for hole at right; in hole at left both insert and bolt were used, and insert was installed after zinc chromate primer, while primer was still wet. Another test specimen with inserts and full length bolts, below, shows negligible corrosion on flanks of threads and minor diameter.

2.–Since the wire is formed on rolls and is not cut with steel tools, the insert need not be passivated. Passivated stainless steel is more widely separated from magnesium on the electrochemical series than non-passivated stainless steel. This may or may not have an adverse effect when inserts are assembled in magnesium or aluminum alloys.

3.–Area of insert is generally quite small compared to the area of the magnesium part in which it is installed, and it is believed that where disproportion of areas is great, galvanic action is small.

4.–Bolt head, washer and clamped member prevent the entrance of electrolyte (salt water or air) which must be present in these configurations to cause galvanic corrosion.

Design Suggestions

When unplated stainless steel wire thread inserts are used in "through" holes assemblies protection against galvanic corrosion will be improved if the insert and bolt are of sufficient length to allow the bold end to protrude at least one pitch through the

Independent Tests Confirm Findings

In addition to the tests conducted by Heli-Coil Corporation in collaboration with Allied Research Products, Inc., Douglas Aircraft Company of Santa Monica, California recently conducted a 330-hr cycle test in a humidity cabinet on magnesium boss materials with unplated stainless steel wire inserts, cadmium-plated stainless steel inserts and cadmium-plated commercial two-piece solid type bushings. This report, identified as Serial No. MP 7438 dated May 20, 1953, concluded that: cadmium-plated inserts were only slightly better than unplated stainless steel inserts. Because of the additional expense of cadmium plating, their use is not warranted. The use of wet zinc chromate primer (MIL-P-6889A) is recommended.

When the locking ring of the commercial two-piece solid type bushing is pressed into place, it cuts through the protective coating inside the hole and promotes corrosive action."

Boeing Airplane Company, Seattle, Washington, also conducted tests (Report No. T-28995) to compare the performance of plated and unplated inserts, and open versus blind holes. The approach, method of testing and recommendations were almost identical to those reported above.

The following conclusions were reached by Boeing: ". . . since both plated and unplated Heli-Coil inserts installed with wet primer were equally free from corrosion and since plated inserts installed without wet primer were only slightly better than unplated inserts installed without primer, the use of cadmium plating is not warranted.

Both plated and unplated inserts installed with wet primer show little sign of corrosion as compared with plated and unplated inserts installed without wet primer. Therefore, neither plated nor unplated stainless steel inserts should be installed in magnesium alloy open holes without wet primer. However, the wet primer may be omitted when installing inserts in blind holes in magnesium and in through holes in aluminum alloys."

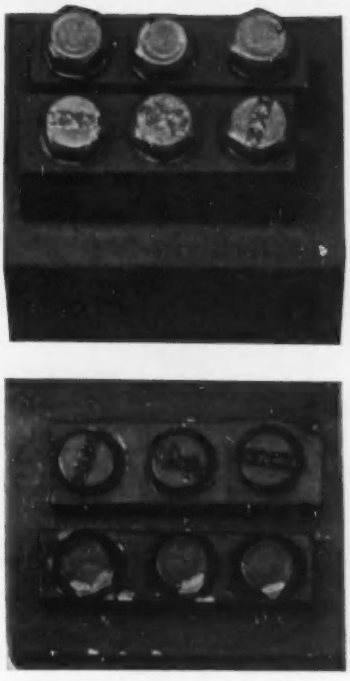


Fig. 3—Aluminum test specimen (A) before and (B) after 500 hr exposure to salt spray. Note almost complete absence of corrosion.

insert and the bottom side of the flange.

Where severe corrosive conditions are anticipated in magnesium assemblies, Iridite 15 or dichromate surface treatments should be used. Also it is recommended that liquid zinc chromate primer (MIL-P-6889A, Type I or Type II) be applied to tapped threads. Insert should be installed while primer is still wet. After assembling carbon steel cadminum plated washer or 52S aluminum washer to bolt, zinc chromate primer should be added to bolt thread, and bolt end with through holes.

When using HAE finishes for magnesium, holes should be plugged before finish is applied. Then, after finishing, zinc chromate primer (MIL P-6889A) should be applied while primer is still wet. Area surrounding the inserts should be coated with primer before assembling mating parts, washers and bolts.

When using unplated inserts in critical aluminum parts it is recommended that a chemical treatment such as Iridite 14 or 14-2 (MIL-C-5541) be substituted for anodizing. This substitution is permitted by specification MIL-S-5002 and is recommended because of dimensional changes which may occur when anodizing. This is particularly important if a class 3 fit is specified. Stainless steel inserts should not be installed before anodizing.

EDITOR'S NOTE: A detailed description of 19 basic uses of thread inserts of the type used in the tests described in this article is given in "Applications of Helical Wire Inserts," page G-16, 1956 Product Design Handbook.

Causes of stress corrosion, corrosion fatigue, impingement, errosion and fretting were discussed in "Mechanical Corrosion," by Russell W. Henke, Product Engineering, January 1956, page 194. Mr. Henke also develops guides for selecting materials to resist corrosive environments and analyzes design factors.

Other methods of protecting metal surfaces were described in "Zinc Coatings for Protecting Steel," E. W. Howick, Product Engineering, December, 1955, page 158.

Earlier articles on corrosion, published in Product Engineering include:

"Cavitation Attack in Ultrasonic Equipment," Dr. L. A. Petermann, September 1955, page 173;

"Optical Corrosion Studies, July 1953, page 205;

"Corrosion Factors in Design and Lubrication," F. L. LaQue, October 1952.

"New Developments in Corrosion Protection," June 1952, page 189.

Edward Goodrich Acheson — 100th Anniversary

THE ONE-HUNDREDTH ANNIVERSARY of the birth of the inventor of the silicon carbide grinding media known commercially as "Carborundum", the discoverer of a means of producing pure graphite, the developer of colloidal graphite and other such lubricating materials was celebrated on March ninth of this year. Born in Washington, Pa., Edward Goodrich Acheson was a self-made scientist and engineer. While on his first job, that of timekeeper at a blast furnace, Acheson completed his first invention, a rock-boring machine patented at the age of seventeen.

How Acheson came to make the experiments that led to the invention of Carborundum is told in his autobiographical notes: "The value of a good abrasive was brought to my attention . . . . I decided to make experiments on clay with carbon.

"An iron bowl, such as plumbers use for holding their melted solder, was attached to one lead from a dynamo and filled with a mixture of clay and powdered coke, the end of an arc light carbon attached to the other lead was inserted into the mixture. The percentage of coke was high enough to carry a current, and a good strong one was passed through the mixture between the lamp carbon and bowl until the clay was melted and heated to very high temperature.

"When cold, the mass was examined. It did not fill my expectations, but I, by sheer chance, happened to notice a few bright specks on the end of the arc carbon that had been in the mixture. I placed one on the end of a lead pencil and drew it across a pane of glass. It cut the glass like a diamond."

Again it was the desire to obtain ever more perfect results that led to the inventor's solution of two puzzling historical questions and, in turn, to the development of many of today's colloidal compounds. Historians had long wondered why the Egyptians used straw in making bricks. Acheson found that tannic acid, extracted from straw, increased the strength and plasticity of certain clays.

Particles of clay so treated were reduced so fine they passed through fine filter paper and remained permanently suspended in water. Applying the same approach to graphite, Acheson managed a sub-division of graphite so that it, too, could be used in water to comprise a colloidal solution. When the inventor added an electrolyte such as salt to these solutions, a flocculation and settling of the suspended matter occurred. In nature, Acheson determined, the same phenomenon occurs when silt-laden fresh water in rivers such as the Mississippi and the Nile reach the salt sea. The formation of the deltas and bars that characterize the mouths of great rivers follows.

Computing Mechanisms—II

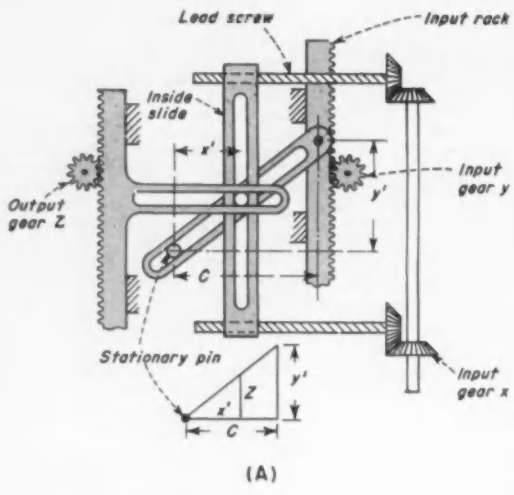


FIG. 1—MULTIPLICATION OF TWO VARIABLES x and y usually solved by either: (A) Similar triangle method, or (B) logarithmic method. In (A), lengths x' and y' are proportional to rotation of input gears x and y. Distance c is constant. By similar triangles: $z/x = y/c$ or $z = xy/c$, where z is vertical displacement of output rack. Mechanism can be modified to accept negative variables. In (B), input variables are fed through logarithmic cams giving linear displacements of *log x* and *log y*. Functions are then added by a differential link giving $z = log\ x + log\ y = log\ xy$ (neglecting scale factors). Result is fed through antilog cam; motion of follower represents $z = xy$.

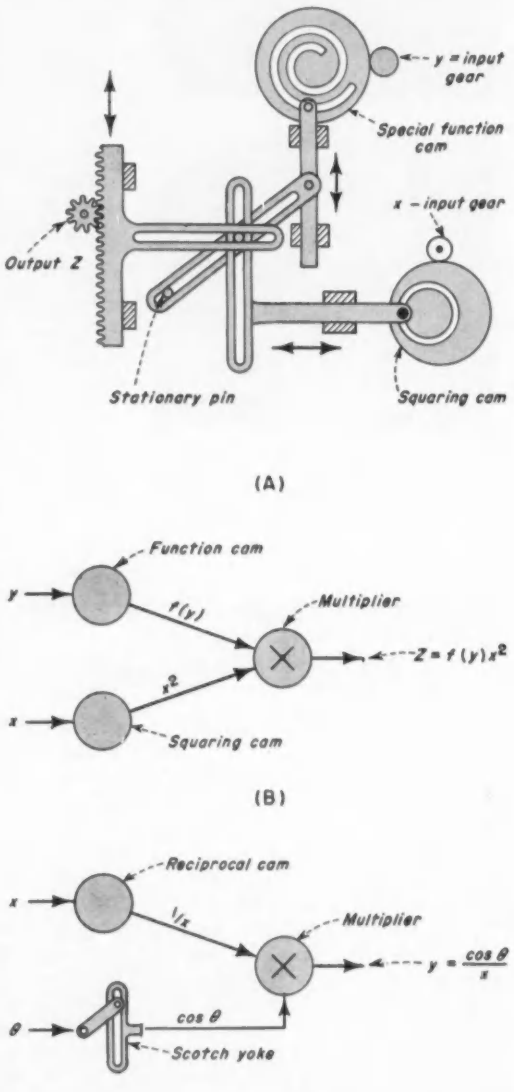
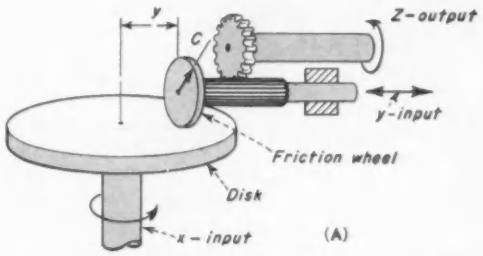


FIG. 2—MULTIPLICATION OF COMPLEX FUNCTIONS can be accomplished by substituting cams in place of input slides and racks of mechanism in Fig. 1. Principle of similar triangles still applies. Mechanism in (A) solves the equation: $z = f\ (y)\ x^2$. Schematic is shown in (B). *Division of two variables* can be done by feeding one of the variables through a reciprocal cam and then multiplying it by the other. Schematic in (C) shows solution of $y = cos\ \theta/x$.

Last month's article, "Computing Mechanisms—I," March 1956 page 200, illustrated analog computing mechanisms for adding, subtracting, resolving vectors, or solving trigonometric functions. This article discusses mechanisms for multiplying, dividing, differentiating or integrating.



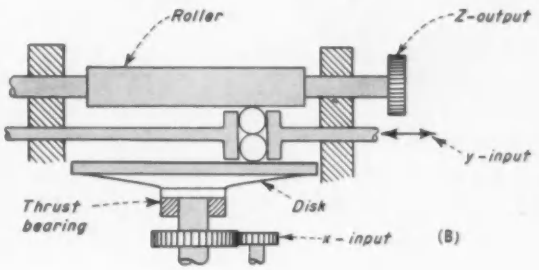


FIG. 3—INTEGRATORS are basically variable speed drives. Disk in (A) is rotated by x-input which, in turn, rotates the friction wheel. Output is through gear driven by spline on shaft of friction wheel. Input y varies the distance of friction wheel from center of disk. For a wheel with radius c, rotation of disk through infinitesmal turn dx causes corresponding turn dz equal to: $dz = (1/c)\ y\ dx$. For definite x revolutions, total z revolutions will be equal to the integral of $(1/c)\ y\ dx$, where y varies as called for by the problem. Ball integrator in (B), gives pure rolling in all directions.

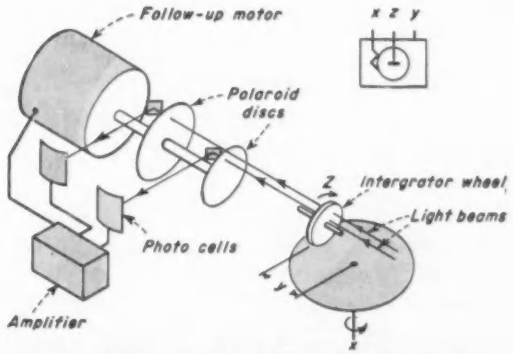


FIG. 4—FOLLOW-UP MOTOR avoids slippage between wheel and disk of integrator in Fig. 3 (A). No torque is taken from wheel except to overcome friction in bearings. Web of integrator wheel is made of polaroid. Light beams generate current to amplifier which controls follow-up motor. Symbol at upper right corner is schematic representation of integrator. For more information see, "Mechanism," by Joseph S. Beggs, McGraw-Hill Book Co., New York 1955.

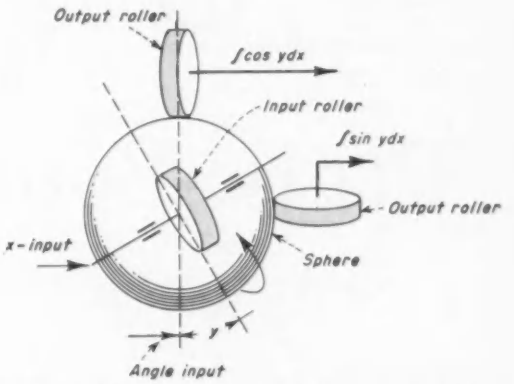


FIG. 5—COMPONENT INTEGRATOR uses three disks to obtain x and y components of a differential equation. Input roller x spins sphere; y input changes angle of roller. Output rollers give integrals of components paralleling x and y axes. *Ford Instrument Company.*

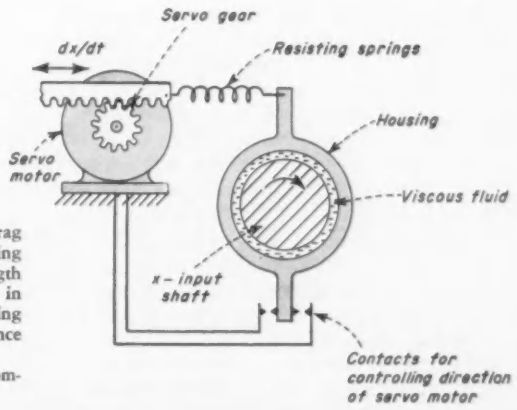


FIG. 6—DIFFERENTIATOR uses principle that viscous drag force in thin layer of fluid is proportional to velocity of rotating x-input shaft. Drag force counteracted by spring; spring length regulated by servo motor controlled by contacts. Change in shaft velocity causes change in viscous torque. Shift in housing closes contacts causing motor to adjust spring length and balance system. Total rotation of servo gear is proportional to dx/dt. From "Mechanical Computing Mechanisms," Reid and Stromback, *Product Engineering*, October 1949 page 126.

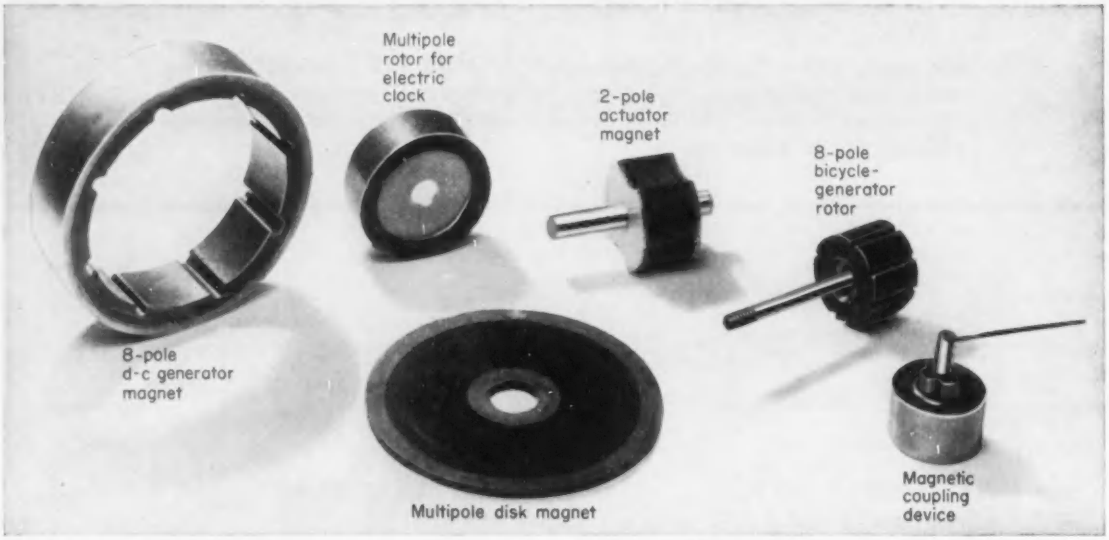


Fig. 1—Compression-molded plastic-bound magnets. Fine particles of magnetic material, usually Alnico, are mixed with a thermosetting resin and molded into efficient complex shapes impossible or impractical to produce in cast form. These magnets can be molded inside soft iron structures; poles pieces, shafts, bushings, or other metal parts can be designed as inserts. The useful energy-product is nearly equal to that of solid Alnico I, II, III, IV, and XLI for magnets of the same weight; magnetic stability of the plastic-bound magnet is excellent, and magnetic and dimensional tolerances are closer than for solid material.

Plastic-Bound Magnets

Advantages and limitations; physical and magnetic characteristics; magnetic properties of cast Alnico and plastic-bound Alnico magnets compared; typical applications.

GERHARD HENNIG
Chief Engineer
Baermann-Nord Corp., Amherst, Ohio

EFFICIENT DESIGN FOR most magnets requires nonstandard shapes and close dimensional tolerances. When using cast Alnico materials these requirements necessitate expensive grinding operations; additional machining is also required to insert shafts or bushings in cast magnets. The plastic-bound magnet offers a more efficient and lower cost method of producing the desired form. In this process the magnetic material in powder form is mixed with resin to make it moldable and then is processed by conventional compression or injection molding methods. This process turns out magnets of complex shapes in one operation; shafts, pole pieces or bushings can be molded in as inserts; dimensional tolerances can be held within limits unobtainable by casting or sintering operations. The method is adaptable to Alnico and iron-barium oxide materials, and the useful energy-product of the molded magnet closely approaches that of the solid material.

Compression-molded plastic-bound magnets used in a variety of applications are shown in Fig. 1. At the far left is an eight-pole d-c generator magnet with the plastic magnet inside a 4-in. diameter soft-iron ring. The synchronous-clock rotor, next, is a cylindrical plastic-bound magnet with the central aluminum mounting plate molded as an integral part; salient poles are not required because of good magnetic stability. The two-pole actuator magnet has a plastic-bound center section with metal plates and shafts molded to both sides. The eight-pole rotor for a bicycle generator has an integrally molded bushing and shaft. The magnet is the same size as an Alnico II magnet used in a similar generator and produces approximately 3 watts at 3200 rpm.

The magnetic coupling device has a four-pole outer magnet in a soft iron ring and a central rotary four-pole magnet. In use, rotation of one magnet is transferred to the other through magnetic coupling. It is used principally in fluid systems for flow indication or measurement. The large flat magnet in the center of Fig. 1 is a disk magnet with several poles around the periphery. The central and outer rings are hard paper which has been molded into the disk to protect the edges against abrasion or rupture.

Magnet Properties

Plastic-bound magnets are composed of ground Alnico particles or iron-barium oxide materials mixed with a plastic binder and compression or injection molded. Loss of residual magnetism and magnetic energy after initial magnetizing is lower when using materials with high coercive force and low permeability. Alnicos with high coercive force and iron-barium oxides are the best materials. However, because of high temperature coefficient of the iron-barium oxides, plastic-bound magnets using Alnico are required where the magnet must remain stable over a wide range of temperature, such as for electrical instrument or meter use.

Physical properties of plastic-bound Alnico magnets are given in Table I, and magnetic properties in Table II. The demagnetization curves of a solid Alnico and a plastic-bound magnet using the same material are shown at upper left in Fig. 2. Comparison of plastic-bound and solid magnets on the basis of standard demagnetizing curves alone can be misleading, because these curves compare a solid magnet with the plastic-bound magnet which has an inherent airgap produced by the small plastic-filled gaps between the bound particles. The effect of this airgap is to increase the percentage of useful residual magnetism.

As an example, standard demagnetization curves at the

Plastic-Bound Magnets

ADVANTAGES

More stable than same material in solid form. Lower eddy-current losses than Alnicos in solid form.

Ratio of total to useful energy higher than for solid material, especially for dynamic uses such as in motors and generators.

Magnetic properties reproducible to within small percentage.

Dimensions reproducible to close tolerances.

Complex shapes produced with ease of plastic machine operations.

Metal pole pieces, bushings, or other inserts can be molded in magnet.

LIMITATIONS

Size limited by capacity of compression or injection molding machine.

Less economical than solid Alnico for static magnetic circuits such as in loudspeakers.

Lower maximum and residual magnetic flux and energy than solid magnets of same material.

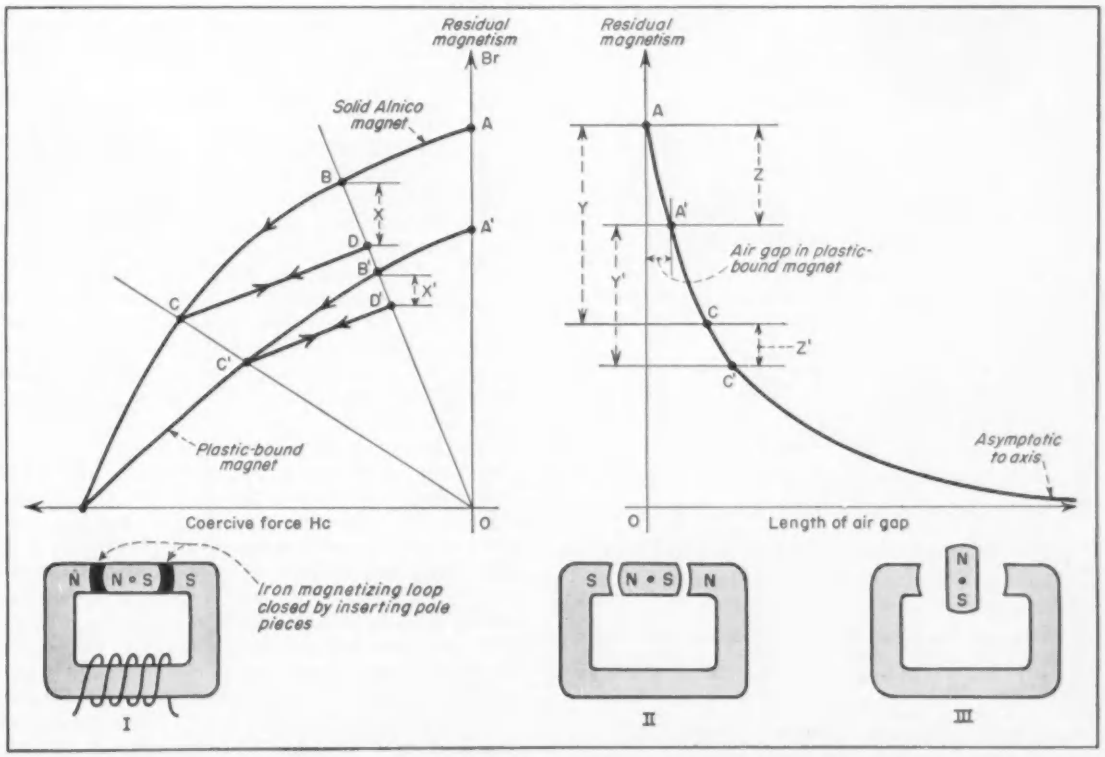


Fig. 2—At upper left, demagnetization curves of solid Alnico magnet and plastic-bound magnet using same material are compared. Although total magnetic energy of plastic-bound magnet is lower, flux density shows smaller variation throughout operating cycle and coercive force is higher than that of similar cast Alnico. Maximum residual induction occurs at point *A* for cast, and at *A'* for plastic-bound magnets when they are a part of closed (no airgap) iron magnetizing circuit shown at *I*. When magnetizing pole pieces are removed, *II*, flux density is reduced to points *B* and *B'*. When rotor is turned to minimum flux (maximum airgap) position *III*, residual magnetism drops to points *C* and *C*. At upper right, effect of air-gap length on residual magnetic flux in solid and plastic-bound magnets are compared. Plastic-bound magnet has inherent air gap.

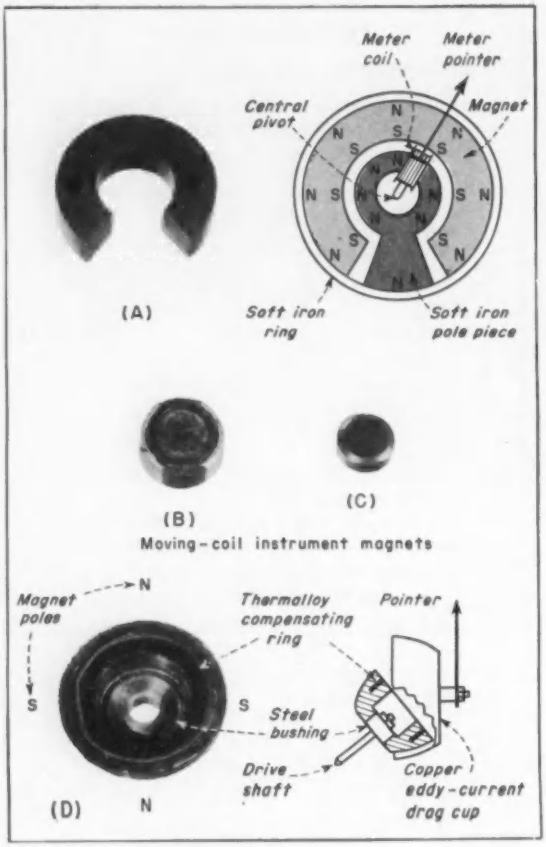


Fig. 3—Compression-molded magnets have high magnetic stability; these four are used for electrical meter and speedometer applications. (A) Wide-scale meter magnet magnetized with one pole on inner radius and other on outer. Meter coil, during assembly is slipped over central portion of soft-iron pole piece through a gap later plugged with a soft-iron wedge. (B) Magnet used in a moving-coil instrument has two iron pole pieces pressed in. (C) Another meter core magnet used in Zeiss Ikon exposure meter. To protect edges of magnet from abrasion brass rings are pressed in both ends. (D) Speedometer magnet molded with integral steel bushing and thermalloy temperature-compensating ring. Magnet has unconventional dome shape and in use is mounted at angle shown in line drawing; when rotated by speedometer shaft, induced currents in drag cup produce torque which rotates cup and attached speedometer pointer. At low temperature thermalloy ring shunts some of magnet flux; as temperature rises permeability decreases, less flux is by-passed and more external flux is available offsetting effect of increased copper resistance and maintaining constant current and torque.

Table I—Physical Properties of Plastic-Bound Magnets

Compression strength	17,000 lb/sq in
Bending strength	1,700 lb/sq in
Specific weight	
Alnico mixture	3.1 to 3.6 oz/in^3
Oxide mixture	2.1 to 2.4 oz/in^3
Shock resistance	125 g
Max circumferential speed	105 ft/sec
Max temperature	400 F
Average coefficient of expansion	15×10^{-6}/deg C

Table II—Magnetic Properties of Standard Types of Plastic-Bound Alnico Magnets

For proper evaluation, B_r and BH_{max} values—obtained in closed iron yoke— must be interpreted as described in text. Non-standard magnets with a BH_{max} of 2×10^6 are also available.

Magnet-Mixture Type No.	Peak Magnetizing Force H, oersted	Residual Magnetism B_r, gauss	Energy Product, $BH_{max} \times 10^6$	Coercive Force H_c oersted
500	3000	3700	0.57	525
700	4000	4400	0.85	635
800	5000	4200	0.97	800
800S	5000	5000	1.23	800
1000	6000	4300	1.30	955

upper left in Fig. 2 are assumed to be derived from solid and plastic-bound Alnico magnets which are magnetized in place in a two-pole iron generator frame shown at *I*. To form a closed magnet circuit with zero air gap, pole pieces have been added. When magnetizing current is applied to the coil and then removed, residual magnetism of the solid Alnico is at point A on the vertical ordinate; magnetizing the plastic-bound Alnico produces a lower residual magnetism at *A'*.

Removing the magnetizing pole pieces introduces a series air gap shown at *II*; the residual magnetic induction drops to point *B* for solid Alnico and to *B'* for the plastic bound. When the magnet is rotated 90 deg to maximum air gap shown at *III*, residual magnetism drops to a minimum at points C and C′ respectively. As magnet is rotated another 90 deg to minimum air gap at *II*, residual induction increases to a reduced maximum at points *D* and *D'*. Constant rotation of these magnets, such as in use in a generator, varies the residual magnetism along minor hysteresis axes C and *D* for the solid Alnico and along C′ and D′ for the plastic-bound magnet. Some residual magnetism of both magnets has been permanently lost, as shown by X, the vertical difference between points *B* and *D*, and by *X'* between *B'* and *D'*. The percentage of residual magnetism retained by the plastic-bound magnet is higher than that of the solid Alnico.

The inherent air gap of plastic-bound magnets produces a useful residual magnetism approaching that of the solid Alnico; this is indicated by the graph at the upper right in Fig. 2 which shows the decrease of residual magnetism with an increase in air gap between magnet poles. If the solid Alnico magnet has a maximum residual magnetism A on the vertical axis, removing the magnetizing poles and rotating the magnet to the position of maximum air gap at *III* reduces residual magnetism by the value Y to point C. The plastic-bound magnet has a lower maximum residual magnetism at point *A'*; the difference between initial residual magnetisms is indicated by Z. When the plastic-bound magnet is rotated to maximum airgap at *III*, residual magnetism drops to a minimum of *C'*. The difference between C and *C'*, or *Z'*, is small; consequently, when used in dynamic applications or with a large air gap the ratio of total energy to useful energy is higher for plastic-bound magnets than for solid Alnico.

The inherent air gaps in plastic-bound Alnico magnets

HISTORICAL NOTE

AN IMPORTANT IMPROVEMENT in permanent magnet materials in 1931 was the development of the Alni- and Alnico materials by a Japanese scientist, T. Mishima. Magnetic energy of these materials was stronger and more stable than the best permanent-magnet steels previously known. However, mechanical properties of these new materials proved to be a stumbling block. Magnets made of Alnico could not be rolled, forged, or machined, even with tungsten-carbide tools; these magnets had to be cast, and subsequent machining done by grinding. It was impossible to cast small pieces since the molten material did not flow well. Large magnets could be cast, but porosity was so severe that scrap was excessive, and the application of Alnico seemed to be limited.

Max Baermann, a German physicist, tackled the problem of converting Alnico scrap, and in 1934 he applied for his first patent in this field. He heat-treated rough broken pieces of Alnico and scrapped castings, then milled it down to particles of 0.1 to 0.001 in. diameter. He mixed these particles with a special thermosetting resin binder and molded the mixture under heat and pressure, producing plastic-bound or "Tromalit" magnets.

MAGNETIC STRENGTH of these new magnets was somewhat less than that of Alnico but much greater than that of steel; in addition, structure of these new magnets was more homogenous than cast Alnico. Use of plastic-bound magnets seemed to be a solution to the scrap problem. This was not realized however. Resins used with the plastic-bound magnets produced a mechanically weak structure; and better casting and grinding methods for Alnico were rapidly developed. Until the beginning of World War II production of these magnets was limited.

In the meantime Baermann and his co-workers had analyzed magnetic circuit design and found new possibilities where application of plastic-bound magnets would be superior for complex mechanical shapes, stability, or economic reasons. Also, by World War II better Alnicos and plastics were available and the former German Navy and Air Force used large numbers of these magnets.

AFTER THE WAR Baermann's equipment was dismantled and sent to Russia, but in 1949 Baermann started again, this time despite the fact that newly developed sintered Alnico approached the high magnetic strength of cast Alnico and also seemed to have most of the advantages of the plastic-bound method. Most of the magnet experts prophesied failure of this new attempt. However, they compared only the magnetic energy of the different materials and overlooked the facts that the overall energy level of magnetic material used is seldom indicative of overall cost or real value of a magnet system. They also failed to recognize the possibilities of more efficient or complex shapes otherwise costly or impossible to grind, made possible by use of compression or plastic injection molding.

Baermann's project proved successful with the principal factory in Cologne, Germany and subsidiaries now in Switzerland and the United States. In fact, one customer, Siemens Co., Germany's largest manufacturers of electrical equipment now use about 6,000,000 magnets a year for watt-hour meter systems which require a magnetic standardization tolerance of 1.5 per cent; Distler Co., another customer, uses over 1,500,000 per year in small motors. These magnets are now being introduced in the United States by the Baermann-Nord Corp.

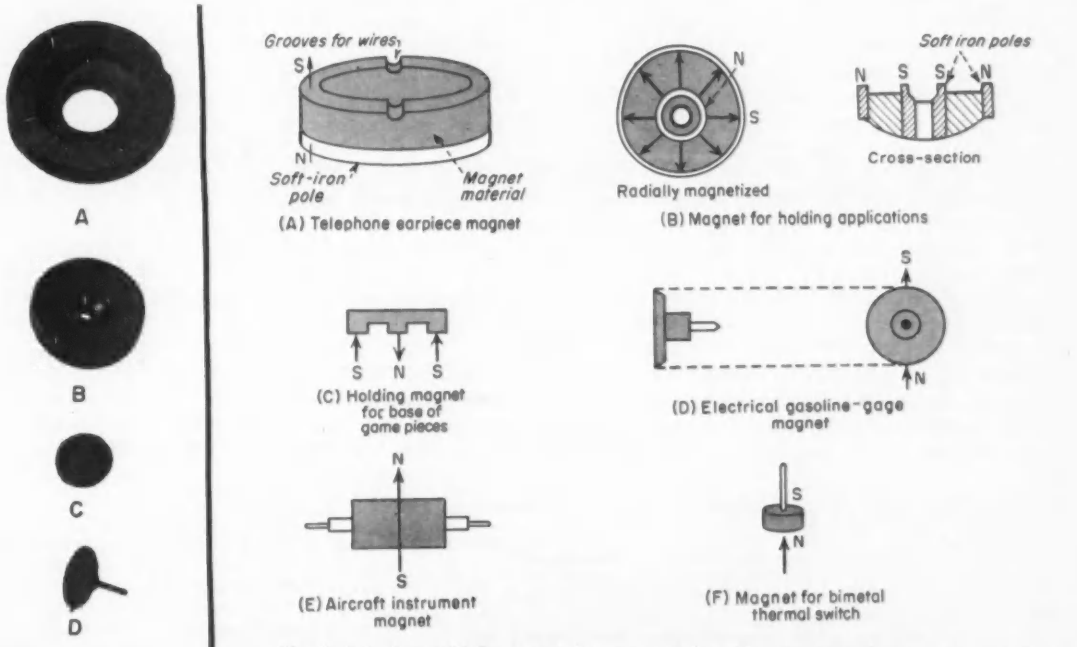


Fig. 4—Injection-molded magnets shown actual size. Line drawings show structures and magnetization. (A) Telephone-earpiece magnet used by Siemens Co. (B) Magnet for tack board or holding function, center and outer poles are shaped to provide maximum holding force. (C) Small magnet used for games or toys; for example, magnet can be molded in base of checkers to hold pieces on board with a ferromagnetic covering. (D) Small magnet used to move pointer of electrical gasoline gage. Magnet shaft is integrally molded; cost is approximately 1.5 cents in large quantities. (E) Aircraft instrument magnet used in cross-coil navigational instrument producing quotient of two inputs. Magnet shaft is integrally molded; cost is approximately 2 cents in large quantities. (F) Magnet for bimetal thermal switch provides positive snap-action.

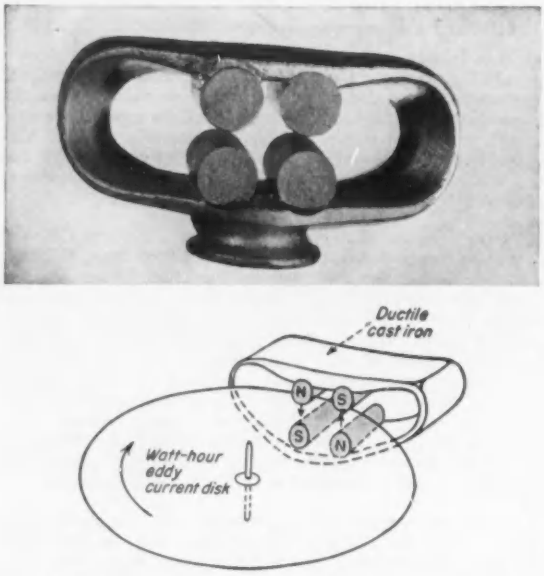


Fig. 5—Magnet assembly used by Siemens for damping in watt-hour meter. Flux in each of the four magnets is held to a tolerance of 1.5 per cent. These magnets are required to be exceptionally stable since heavy current surges, such as from lightning, could affect meter calibration.

decrease electrical conductivity and eddy-current losses when used for generators or motors. An example is the rotating multipole magnet of the bicycle generator shown in Fig. 4. This application required a solid Alnico magnet with a B_r of 5500 gauss, a coercive force H_c of 530 oersted, and an energy of at least 1.08 x 10^6 BH_{max}. A plastic-bound magnet with a B_r of 3800 gauss, a coercive force H_c of 620 oersted, and an energy of less than 0.8 x 10^6 BH_{max} performed the task. As an experiment, a solid Alnico magnet was fabricated with these same properties, but the generator output was 18 per cent less. This example demonstrates how a comparison of plastic-bound and solid magnets on the basis of standard data can be misleading; the superiority of the plastic-bound magnet in this application could not be determined by comparing maximum residual energy B_r or external demagnetization curves such as shown in Fig. 2.

Most important advantage of plastic-bound magnets lies in the ease with which they can be fabricated to close dimensional tolerances; the molding process has all of the accuracy inherent in plastic molding operations. In addition, relatively complex shapes can be formed in a single operation, whereas the solid magnets require expensive grinding. The molding process permits incorporation of shafts, iron pole pieces, temperature-compensating material, or other integral elements of the magnet.

Another advantage of plastic-bound magnets is the close magnetic-flux tolerances to which they can be produced. Magnetic properties of sintered Alnico magnets vary because of various influences during the powdered metal process and subsequent heat treatment; the properties of plastic-bound magnets can be controlled in the cold mixture of magnetic grains and binder because the material is heat treated before it is mixed.

Current Applications

The stability and uniformity of plastic-bound magnets has produced wide-spread use abroad in a wide variety of electrical measuring instruments. Injection-molded meter magnets have been produced using thermoplastic binders. Typical low-cost tiny magnets made by this method are shown actual size in Fig. 4. The magnetic element of a watt-hour meter used for eddy-current damping is shown in Fig. 5. The four magnets are manufactured with a magnetic tolerance of ±1.5 per cent. They are cemented in the cast-iron housing using an epoxy resin.

For designs requiring maximum flux density in a given space, solid Alnico V is preferred to plastic-bound magnets. Also, for simple shapes or magnets requiring little or no machining, cast or sintered Alnico or sintered oxide magnets usually can be produced more economically than plastic-bound magnets of the same composition.

Where machining costs are high, such as in grinding uneven surfaces, or when a magnet is required to have an accurately centered hole, plastic-bound magnets are recommended. For example, the magnet for a small d-c motor, shown in cross-section view in Fig. 6, required a hole concentric within 0.002 in. The motor required a low priced magnet which precluded use of ground Alnico; in this case the magnetic circuit was ideal for a material with high coercive force, while residual induction was not so important. Plastic-bound magnets were initially made out of Alnico, later changed to iron-barium oxide.

Multipole magnets, particularly those with poles inside a ring, are difficult to fabricate from either sintered or cast Alnico, but can be readily made by the plastic-bound process using oxide materials as well as Alnico.

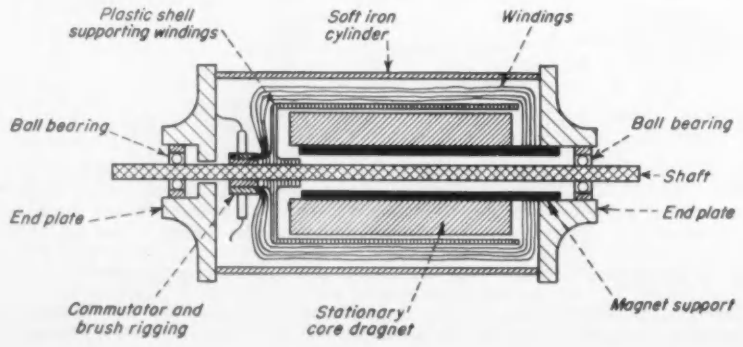


Fig. 6—Application of plastic-bound magnet in small d-c motor by Distler; motor is used in battery-operated phonographs, toys, and other devices. Field magnet is stationary and located inside armature coils wound on a plastic cylinder; left end of cylinder is attached to shaft. Armature coils revolve around stationary field magnet similar to meter coil in moving-coil instruments. Some versions of this motor operate from photoelectric cells. Both Alnico and iron-barium oxide materials have been used for magnet.

General Electric Co.
American Machine and Foundry Corp.

nuclear reactors

POSE NEW PROBLEMS IN MECHANICAL DESIGN

MATERIALS Conductivity and reflectivity of neutron radiation; effects of radiation on physical properties.

MECHANICAL COMPONENTS Special requirements placed on valves, pumps, seals and bearings; designs developed for nuclear reactors.

CONTROLS Functions of control rods; systems for automatic operation and safety control; remote handling and viewing.

Copyright 1956 by McGraw-Hill Publishing Company, Inc.

Materials

THE DIFFERENT MATERIALS for various purposes contained in a nuclear reactor include the fuel and fertile materials, moderators and reflectors, reactor structural members, fuel canning or cladding, reactor shielding and controls and effective coolants. Table I shows the thermal neutron cross sections for common reactor materials.

Materials are selected which have small neutron absorption cross sections to keep from wasting neutrons except for control materials where large absorption is desired. In fissionable material a large fission cross section is desired and a low non-fission capture one.

The fissionable material is clad with a thin sheet of aluminum or zirconium, either pure or alloyed, or with stainless steel. This protects the fissionable material from corrosion by the coolant and prevents the escape of radioactive fission fragments into the coolant. The fertile materials, U238 and Th232, which are used to make new fissionable materials, Pu239 and U233 respectively, by neutron capture, are clad with the same metal as the fissionable material.

When the fissionable material is in the coolant, as a chemical compound or a physical mixture, corrosion of the container must be prevented. These reactors are homogeneous types and the coolant media are aqueous solutions, fused salts and liquid metals.

A good moderator is a material which reduces the speed of the fast neutrons in a small number of collisions and absorbs few of them during this process. Acceptable moderators are light and heavy water, graphite, Be, BeO, Li and B. Lightweight elements are unacceptable because of their high neutron absorption.

Control of the rate of fissioning, for a uniform release of energy over a long period of time require strong neutron absorbers. Control of thermal and intermediate energy reactors is obtained by the appropriate distribution among the fuel elements of B, Cd and Hf rods which may be moveable. Fast reactors are controlled by reflectors; since the absorption cross sections for fast neutrons are quite low rods are not effective. Good reflector materials are hydrogen and deuterium followed by beryllium and carbon.

The vessel containing the core is of a size, shape and strength depending on reactor design, radiation exposure and other variables. The most commonly used vessel materials are aluminum, zirconium, either pure or alloyed, and stainless steels. Table II lists the slow neutron absorption of structural materials.

Extensive shielding is required to absorb radiation from the core through the vessel. To absorb the escaping neutrons hydrogeneous materials are used to slow down the neutrons to thermal energy regions where they are readily captured by such materials as boron. Boron is generally in the form of boron carbide or boral. Gamma rays require high density materials such as iron, concrete, or concrete combinations.

EFFECTS OF IRRADIATION

The following effects of irradiation have been observed on solids: decrease in density and ductility; increase in hardness and strength; and changes in dimensions and magnetic susceptibility. The type of effect depends on the solid under irradiation such as: metals and alloys; ionic compounds and ceramics; molecular solids, for example plastics; and semiconductors.

Radiation damage is caused by the displacement effects or ionization effects. Organic materials are generally affected by beta, gamma and neutron radiation and the disturbances in these materials are caused by ionization. Metallic solids, being good electrical conductors, are mainly affected by neutron radiation.

Metals: Changes in the properties of metals that occur on exposure to neutron radiation resemble the changes occurring as a result of cold working, although the mechanism of these changes are entirely different. A correlation also seems to exist between the degree of cold working, the heat treatment of the metal, and the extent of changes under irradiation.

Some experimental data are shown in Figs. 1 and 2 on the effects of irradiation on the tensile and yield strength and the hardness of various metals. Radiation increases the hardness very little in the hardened metals but considerably in the annealed metals. Lattice dislocations and defects produced by hardening lower the effect of irradiation especially when compared with the annealed metals which are characterized by undisturbed lattice structures.

This affect can be explained by the experiments on copper-gold for changes in electrical resistivity. Copper-gold is a well-known example of an order-disorder alloy. It can be brought to any state of order by appropriate heat treatment. Electrical resistivity depends on the state of order. Table III shows the effect of irradiation on order and disorder alloy states before and after irradiation. The increase in resistivity of the ordered samples is more than 100 per cent greater at high neutron exposures. Disordered samples show no change.

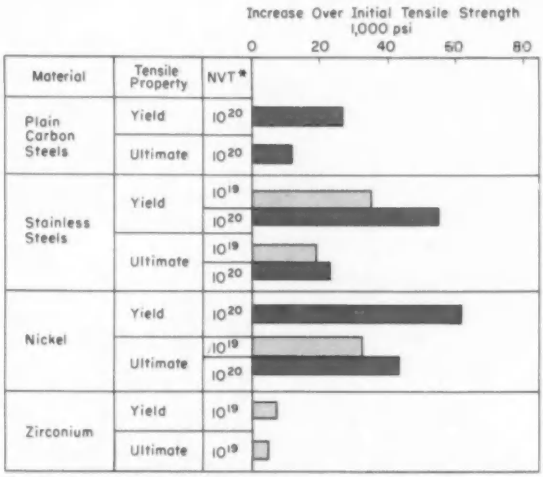
Ionic Compounds and Ceramics: These materials are usually good insulators since they have no conduction electrons. Under irradiation, the particles are dissipated in ionization, disappearing quickly, and resulting in the heating of the material. In an insulator the electrons liberated by ionization may be trapped at various lattice imperfections and result in a property change of the material. The thermal conductivity decreases and large thermal stresses may be formed. Decreases in Young's modulus and in the breaking strength because of a weakening of the crystal lattice have been reported. Dielectric strength is also reported to decrease.

In general, at low temperature ceramic materials do not have the ability to flow plastically and thus relieve their excessive internal stresses. At elevated temperatures, it develops plastic flow and the effects of irradiation may not be as severe.

Plastics: Plastics and other molecular solids show striking changes caused by radiation. Fig. 3 shows the effect of exposure on the tensile and impact strength, and the elastic modulus of polyethylene. The electrical resistivity of polyethylene and Teflon remain relatively high after irradiation; and any failure as an insulating material is probably caused by mechanical deterioration rather than from changes in electrical properties.

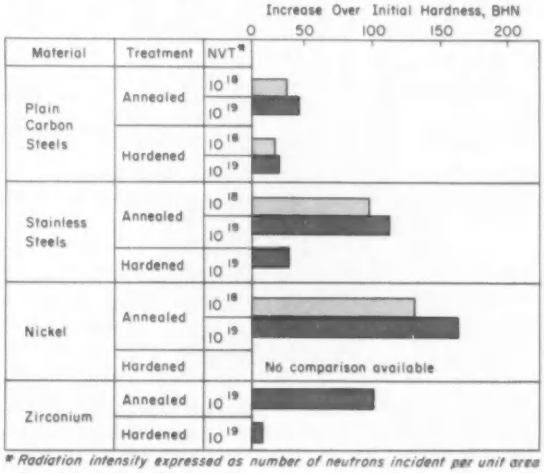
A useful effect of the ionizing radiation is the cross-linking of molecules in plastics such as polyethylene. This effect is to change the plastic properties so that material is elastomeric at 115 C; the unirradiated material softens at 80 C and liquifies at 115 C.

Semi-Conductors: Trace impurities in a semi-conductor can cause large property changes. When exposed to fast neutrons and fast charged particles, electron traps are produced, with a resultant change in electrical properties. In the fast particle bombardment of n-type germanium, acceptors which trap conduction electrons, lower the electrical conductivity. Additional bombardment converts the material into the p-type. Further bombardment of the converted material then results in the production of positive holes and an increase in the conductivity. Fig. 4 shows the effect on a semi-conductor.



*Radiation intensity expressed as number of neutrons incident per unit area for total exposure time.

Fig. 1 — Effect of irradiation on the yield and tensile strength of various materials. Values are increase over initial property.



*Radiation intensity expressed as number of neutrons incident per unit area for total exposure time.

Fig. 2 — Effect of irradiation on the hardness of various materials. Values are increase over initial Brinell hardness number.

Table I — Thermal Neutron Cross Sections for Common Reactor Materials

Material	Use	Fission	Nonfission Capture
U-233	Fuel	533 barns	52 barns
U-235	Fuel	580	107
Pu-239	Fuel	750	351
U-238	Source	0	2.8
Th	Source	0	7.0
Nat. U	—	4.09	3.5
Al	Clad, Structural	—	0.21
Zr	Clad, Structural	—	0.18
347 St. St.	Clad, Structural	—	2.9
Inconel X	Clad, Structural	—	4.1
Be	Moderator	—	0.009
BeO	Moderator	—	0.009
Graphite	Moderator	—	0.0045
H_2O	Coolant Moderator	—	0.66
D_2O	Coolant coolant	—	0.00092
Na	Coolant	—	0.50
B	Control	—	750
Cd	Control	—	2400
Hf	Control	—	120

Table II — Slow Neutron Absorption by Structural Materials

Material	Relative Neutron Absorption per cm^3 x 10^2	Relative Neutron Absorption for Pipes of Equal Strength (20 C)	Melting Point, F
Magnesium	3.5	10	1200
Aluminum	13	102	1230
Stainless Steel	226	234	2730
Zirconium	12.6	16	3330

Table III — Resistivity* of Cu, Au Samples Before and After Irradiation

Neutron Flux(1)	Ordered Samples		Disordered Samples	
	Before	After	Before	After
0.4	4.60	5.71	11.20	11.25
0.6	4.60	6.25	11.20	11.25
1.0	4.60	7.54	11.20	11.17
1.5	4.60	8.36	11.20	11.21
3.3	4.60	10.10	11.20	11.30

*Unit of Resistivity: 10^{-6} ohm-cm
(1) Unit of flux: 10^{16} neutrons per sq cm. Samples were exposed at various positions in the pile at 40 C and the integrated flux per sq cm of neutrons with energy above 50,000 eV are as shown.

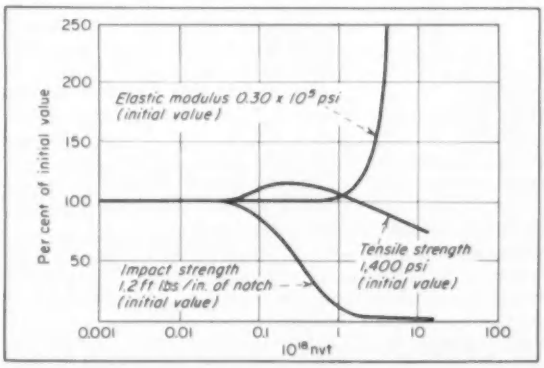


Fig. 3 — Tensile strength, impact strength and elastic modulus property changes in polyethylene caused by irradiation.

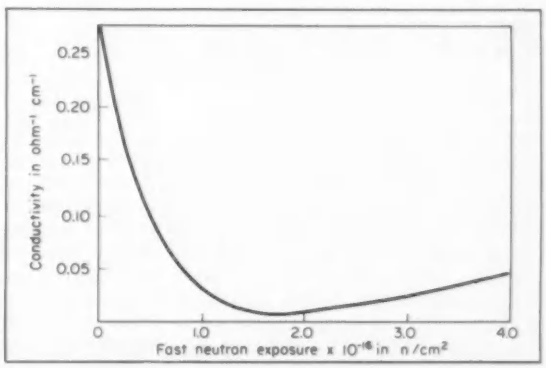


Fig. 4 — Effect of irradiation on a semi-conductor. Changes caused by neutron bombardment may be removed by annealing.

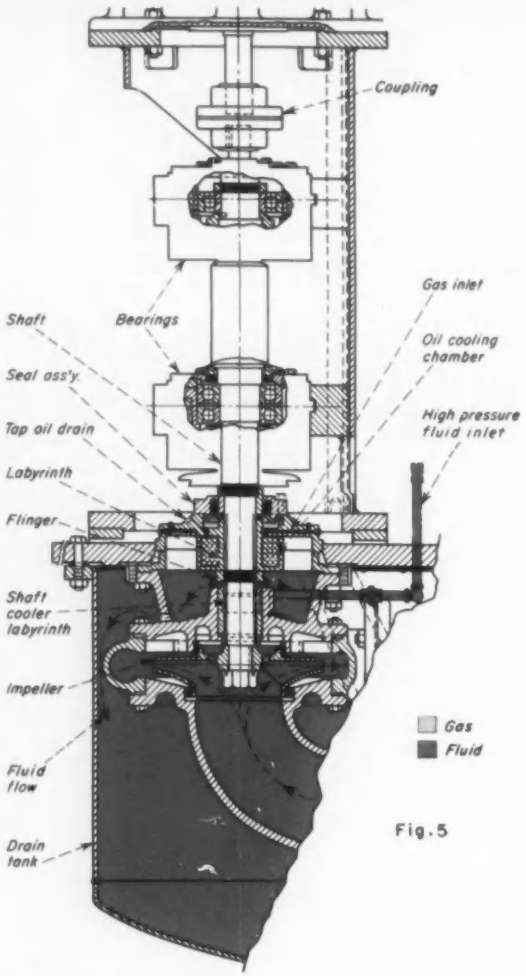


Fig. 5

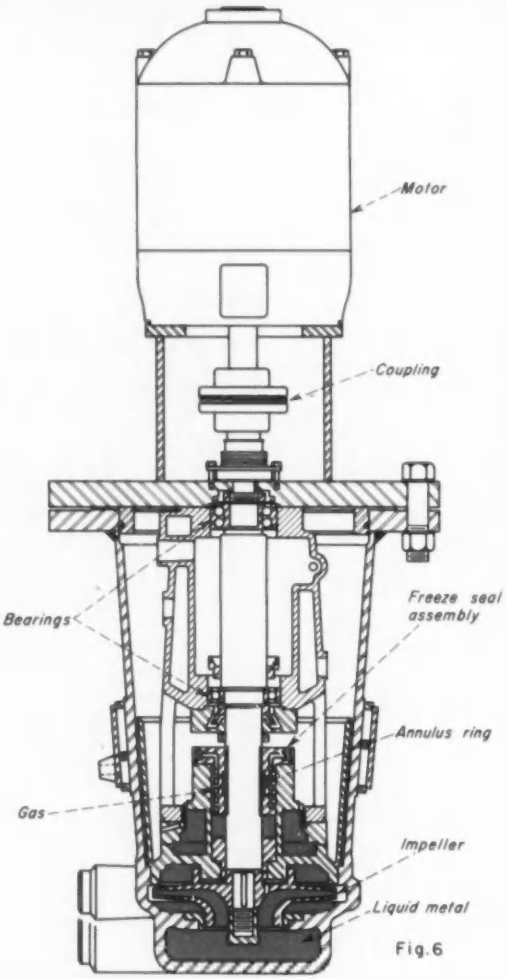


Fig. 6

Fig. 5—Shaft seal pump designed by General Electric Co. Liquid metal flow through labyrinth is controlled by inlet flow of high pressure liquid metal. Flow passed labyrinth is stopped by flinger. Penetration of flinger by pumped fluid is controlled by inert gas blanket. Upper seal prevents gas from escaping or air from entering assembly. Oil and gas mixture is removed through tap oil drain.

Fig. 6—Frozen sodium seal pump. Seal is frozen with 200 F toluene and balanced pressure over seal results in substantially zero leakage. Ball bearings are oil lubricated and bearing bracket is mounted in a helium gas sealed can.

Pumps

FROM A PURELY HYDRAULIC STANDPOINT, pumping of nuclear reactor fluids is relatively easy. There are a large number of materials which are sufficiently corrosion resistant to be usable as structural materials in pumps up to about 1000 F. With the exception of bearings, choice of materials is not usually a major factor.

There are, however, general requirements that have made special design and development necessary for high-temperature nuclear system pumps. These are:

1) Ability to pump high-temperature liquids. This problem is not unique; however, special features in the design of windings and drive motors are necessary.

2) Ability to operate without maintenance. Since maintenance is a problem because of radiation hazards, attempts are being made to minimize or eliminate parts subject to wear and fatigue and components requiring adjustments.

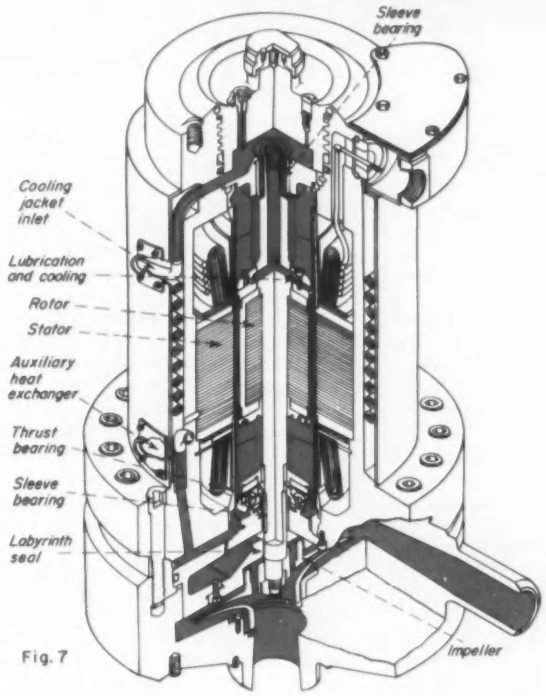
3) The necessity of leakless or nearly leakless operation. This is usually the governing factor in the design and selection of pumps and has led to the development of unusual means for sealing mechanical pumps as well as the development of electromagnetic pumps which are inherently leakless.

In addition, the unique features of an application may dictate the type of pump to be used and also influence its design. These are:

1) Space available for the pump.

2) Source of power for the pump and space available for special power supplies.

3) Available auxiliary systems — water or gas cooling, bearing oil supply, available provisions to vent bleed off gases and other similar factors.



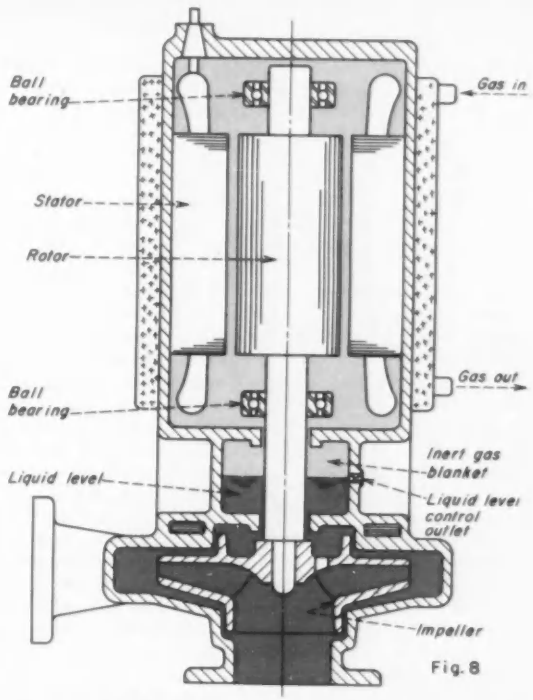


Fig. 7—Canned-rotor pump manufactured by Westinghouse Corp. Fluid handled completely fills the pump and lubricates the bearings. Motor heat is dissipated to secondary cooling water flowing around the wrap around tubes of the integral heat exchanger. Labyrinth seal and thermal barrier minimizes fluid flow and heat transfer between pump casing and motor cavity.

Fig. 8—Canned-motor pump. Rotor and stator operate in an inert gas. Liquid level is controlled by auxiliary equipment to maintain a set level. Ball bearings are oil or grease lubricated. Other methods may be used to keep circulating fluid out of motor.

4) Relative importance of pump weight in the over-all system design.

5) Fluid circuit characteristics and location of free surfaces — whether the pump is required to pump from a sump into an overhead tank or to circulate in a closed system.

6) Pressure available at the pump inlet to prevent cavitation.

7) Method of speed control — whether the pump operates at constant flow or whether flow is variable, and how the variation is obtained.

8) Whether pump is stationary in space or is required to operate under conditions of pitch, roll and mechanical shock expected in a mobile plant.

MECHANICAL PUMPS

The problems met in the design of mechanical pumps for nuclear systems with certain exceptions are those met in any pump design. Cavitation parameters, for example, in liquid metal systems appear to follow laws governing this phenomenon in other fluids. It has been observed that during conditions of severe cavitation the rate of loss of material in 400 F sodium is several times that in water at room temperature.

The operation of bearings in liquid metal is difficult because of the increased tendency of material to gall when rubbing. This markedly reduces the life of most antifriction bearings and limits the selection of materials for slider-type bearings.

The problem of obtaining an adequate shaft seal has led to a number of methods which so influence the pump design that mechanical pumps can be classified by the method of sealing off the drive components.

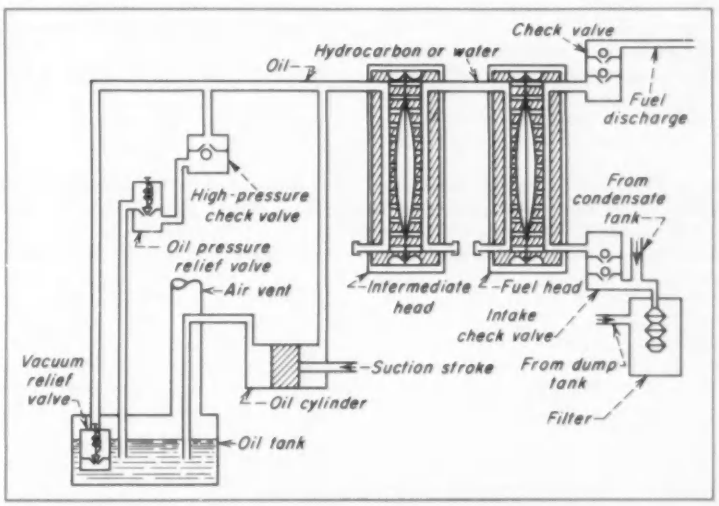


Fig. 9—Flow diagram for Lapp Insulator Co., Inc., diaphragm pump. Setup permits the isolation head and the hydraulic mechanism to be located outside of the shield. The only operating mechanism in the radioactive region of the nuclear reactor are the primary diaphragm and the check valves of the system.

Shaft seal pumps — Pumps using

shaft seals are the nearest in design to conventional units, Fig. 5. The shaft can be driven by the most suitable means — a-c, d-c, turbine, or other conventional prime movers — which allows maximum flexibility of control and minimizes or eliminates special power supplies. Conventional bearings are used and lubricated in a normal manner.

Shaft seals which seal pumped fluid directly have generally been found unsuitable. Some pumps use a double-seal arrangement in which the leakage through one seal is accumulated in a reservoir under an inert gas blanket; the second seal serves to prevent leakage of the gas. This arrangement requires an auxiliary system to accommodate the fluid leaking past the first seal and successful operation depends on the maintenance of proper fluid levels throughout the entire system. Effective periods between maintenance are usually limited by the operation of the gas seal.

Shaft seals using frozen sodium have been used on small shafts with moderate success, Fig. 6. Sodium is allowed to leak into a thin annulus surrounding the shaft; the temperature in this region is kept below the freezing point by means of forced cooling. As a result of friction, a thin film of molten sodium is maintained immediately around the shaft. The film can withstand moderate pressures without being expelled.

Canned-rotor pumps – In canned-rotor pumps, sealing is accomplished by means of a thin cylindrical liner interposed in the air gap between the stator and the rotor of the induction motor which drives the pump, Fig. 7. The end of the liner facing the impeller is welded to and open to the main pump body, which is made leak tight and filled with the pumped fluid. The opposite end of the liner usually contains a radial bearing and is welded closed. Pumped fluid generally fills the gap and surrounds the rotor; the pumped fluid serves to remove rotor heat losses, and lubricates the bearings which are entirely internal. Forced cooling of the stator windings is necessary and is usually accomplished by a water jacket on the motor yoke. An auxiliary heat exchanger is required to remove the rotor losses from the pumped fluid which flows through the gap; this portion of the pumped fluid is kept separate from the main stream and maintained at as low a temperature as can be tolerated without causing an excessive concentration of oxides within the pump.

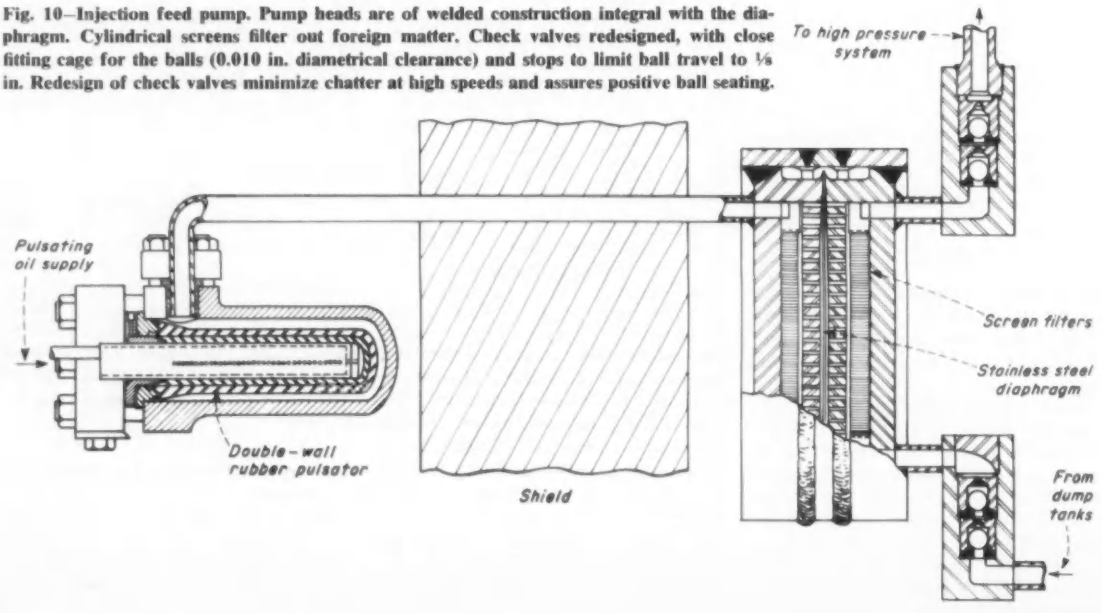
Canned-rotor pumps are generally compact. They require circulating-liquid cooling systems which occasionally must have special temperature controls. The use of forced air or gas cooling simplifies the pump design but usually requires gas-monitoring systems and excessive shield penetrations. Since they are totally sealed, these units require no vent or bleed off and are independent of the location of free surfaces in the system. Power must be supplied from a suitable a-c source. If voltage control of flow variation is required, the drive motor must be oversize and must contain special design features. Speed variation is limited to a range of about 20 to 100 per cent of full speed by bearing operation if either hydrodynamic or internally supplied pressure pad bearings are used. This range can be extended to substantially zero per cent if externally supplied pressure pad bearings are used. Efficiencies up to 55 per cent have been obtained.

Canned-motor pump—In the canned-motor pump, the drive motor, pump shaft, and bearings are enclosed in a hermetically sealed vessel in which an inert-gas blanket covers the pumped fluid; this avoids shaft penetrations of the gas blanket and its associated seal, Fig. 8. Conventional bearings may be used, and precautions are taken to prevent the diffusion of pumped fluid vapor into the bearings and motor.

Pumps of this type have been used in stationary applications, usually as a sump-type pump when liquid level control can be maintained by gravity. Since these units are totally enclosed, vents and auxiliary systems are not required. The canned-motor pump is not particularly compact because the motor and gas vessel are gas-cooled. Because of high wear of carbon brushes operated in the absence of water vapor, d-c motors have not been required. The problems associated with the use of an induction motor are the same as for those using an induction motor driving a canned-rotor pump.

Positive displacement pumps—Pump consists essentially of a diaphragm and check valves actuated by a reciprocat-

Fig. 10—Injection feed pump. Pump heads are of welded construction integral with the diaphragm. Cylindrical screens filter out foreign matter. Check valves redesigned, with close fitting cage for the balls (0.010 in. diametrical clearance) and stops to limit ball travel to 1/8 in. Redesign of check valves minimize chatter at high speeds and assures positive ball seating.



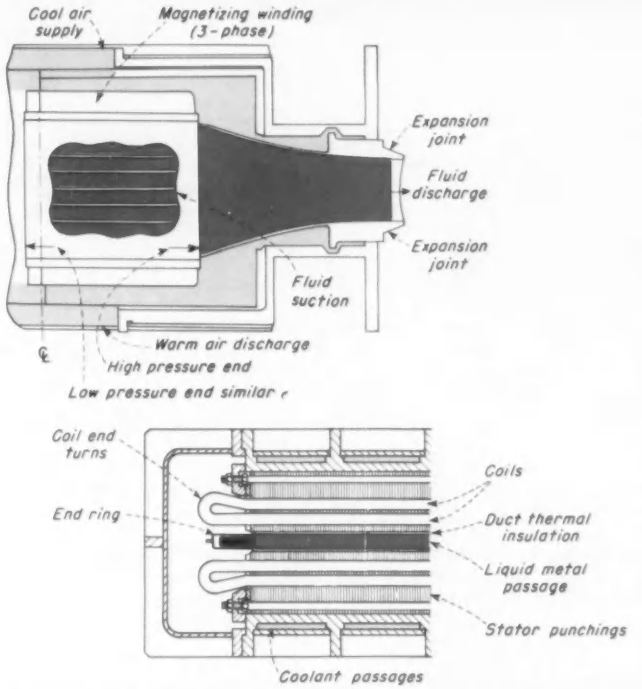


Fig. 11—Linear induction pump of Medium Induction Motor Dept., General Electric Co. manufacture. A three phase alternating voltage applied to the windings establishes a multipole field with adjacent poles of alternate polarity. Field moves down the duct, moving one pole pitch every half cycle. Moving field induces currents in the fluid which makes the fluid follow the field. This type of electromagnetic pump is used for relatively large flows at moderate heads and where space and power supplies are at a premium.

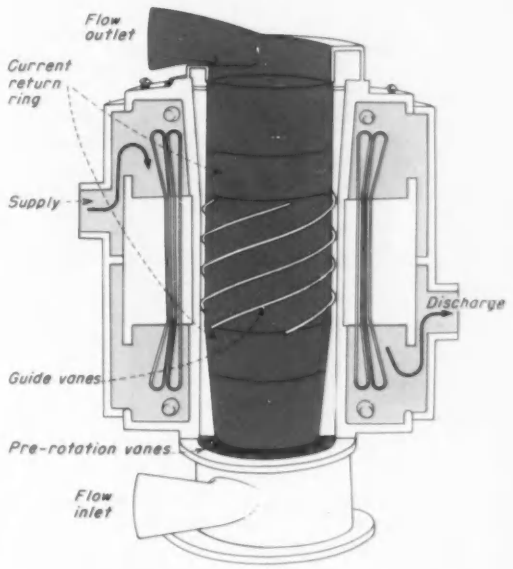


Fig. 12—Helical induction pump designed by General Electric Company. Three phase winding creates a rotating multipole field. This field, by inducing voltages in the fluid, causes a pattern of currents to flow in the fluid similar to those which flow in the motor of an induction motor. Copper rings return the current. Cooling air reduces heat of the stator winding. This type of pump is used for high pressure and low flow and where size is at a premium.

ing oil pump, Fig. 9. It is used for pumping small volumes (1 to 2 gpm) against high pressure (1000 to 2000 psi). Its design offers several advantages:

1) It is relatively simple and inexpensive.

2) The diaphragms are within the shield, thereby isolating the radio-active fuel. As there are two diaphragms, a rupture would not allow any radio-active material to escape from the shield.

3) The operating mechanism is outside the shield and easily accessible. There are no mechanical parts within the shield other than the diaphragms and check valves.

Each diaphragm is contained in a head assembly consisting of two machined flanges, between which the diaphragm is seal-welded, and a hoop into which the diaphragm and flanges are strength-welded. The faces of the flanges are contoured so that stress throughout a diaphragm will be essentially uniform when it is flush against the flange face. The maximum calculated stress in the diaphragm is 20,000 psi permitting long-term operation without fatigue failure. Present design will withstand static pressures up to 5000 pounds per square inch.

As shown in Fig. 9 the pump operates as follows: on the suction stroke of the oil pump, the intake ball-check valve opens, allowing the liquid being pumped to enter the pumping head at atmospheric pressure. As the oil piston reverses, the intake check valve seats, and the liquids in the connecting lines are compressed until the pressure in the system exceeds the pressure above the discharge ball-check valve, opening it and allowing the fluid to flow out.

The vacuum relief valve and the pressure relief valve on the oil pump are essential to the operation. If the system pressure exceeds the pressure relief valve setting, which happens when either of the diaphragms "bottoms" against the flange before the piston reverses, the valve opens, and oil flows out of the oil leg of the system until the piston reverses. If either of the diaphragms bottoms before the piston completes its suction stroke, the vacuum relief valve opens, allowing oil to re-enter the oil leg of the system.

Parts of the system coming in contact with corrosive liquid are constructed from type 347 stainless steel, and the ball-check valves are fabricated from stellite, which is resistant to both physical wear and corrosion.

Since the bolted construction would be a potential source of leakage, reactor pump heads of all welded construction, Fig. 10, were designed. The diaphragm seal weld is made by fusing the stainless steel diaphragm and the thinned edges of the two flanges together with a Heliarc torch.

Early operation of these units resulted in failure of the diaphragm near the edge. Examination indicated foreign matter in the diaphragm cavity which had punctured the diaphragm or had severely cold worked the metal causing fatigue cracks because of constant flexing. To exclude the foreign matter cylindrical screens in the head passages on either side of the diaphragm were added.

ELECTROMAGNETIC PUMPS

Electromagnetic pumps, which use the effect of electromagnetic forces on the liquid metal, have been the subject of extensive development for the past few years.

All electromagnetic pumps have the desirable feature of requiring no pene-

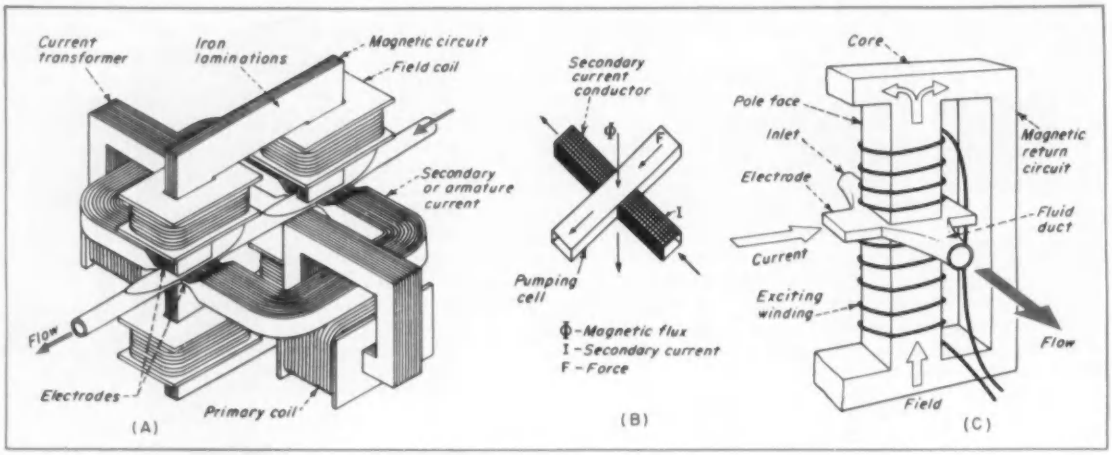


Fig. 13—Faraday pump manufactured by Callery Chemical Co., (A) for liquid metal systems. Current passing through the flow, perpendicular to a magnetic field, produces a force on the liquid metal resulting in fluid motion. The motion is at right angles (B) to the current and flux. (C) is a schematic of a d-c Faraday pump showing current, field and flow directions.

tration into the liquid metal which makes complete sealing possible. Their size and weight are similar to mechanical pumps of the same rating. They require no venting or gas bleed lines, are independent of the location of free surfaces in the fluid system, and normally have characteristics which are independent of their orientation in space.

Electromagnetic pumps contain the liquid metal in ducts which vary in wall thickness from about 0.025 to 0.060 in. Normal practice includes secondary supports for these thin walled members so that they are not required to withstand operating pressures of the pumped liquid.

Cavitation of the fluid near these thin-walled members must be avoided. Tests indicate that maintaining a total pressure at the pump inlet approximately 2.5 times the maximum velocity head is sufficient to prevent cavitation, provided the hydraulic passages are reasonably well designed.

All the electromagnetic pumps use the principle that a conductor in a magnetic field, carrying a current which flows at right angles to the direction of the field, has a force exerted on it, the force being mutually perpendicular to both the field and the current. In all of the electromagnetic pumps the fluid is the conductor. This force, suitable directed in the fluid, manifests itself as a pressure if the fluid is suitable contained. The field and the current can be produced in many ways and the force used in ways to move the liquid metal.

Types of pumps which are fairly well developed are the a-c linear induction pump, the a-c helical-flow induction pump, and the a-c and d-c Faraday type.

Linear induction pump—This pump uses a multipole field traveling axially down the fluid duct, Fig. 11. The field is produced by polyphase a-c windings located on two sides of the duct, normally of rectangular cross section. Present practice is to limit fluid velocities to about 40 fps or less and to maintain an aspect ratio in duct cross section of about 24:1.

Since the windings must be close to the hot liquid-metal duct, their cooling requires special attention. Pumps can be designed to use either gas or water cooling, and moderate winding temperatures can be maintained with reasonable quantities of coolant.

Efficiencies of about 40 per cent have been obtained and 50 per cent does not seem unreasonable. The power factor is low, usually about 40 per cent. Improvement in efficiency can be obtained at the expense of a reduction in power factor. Linear pumps can be designed to operate at 60 cps voltages.

The characteristics of the pump make it suitable for operation over a wide flow range using voltage control. The low power factor requires either high KVA rating alternators or power-factor-correction equipment, such as capacitors or similar component.

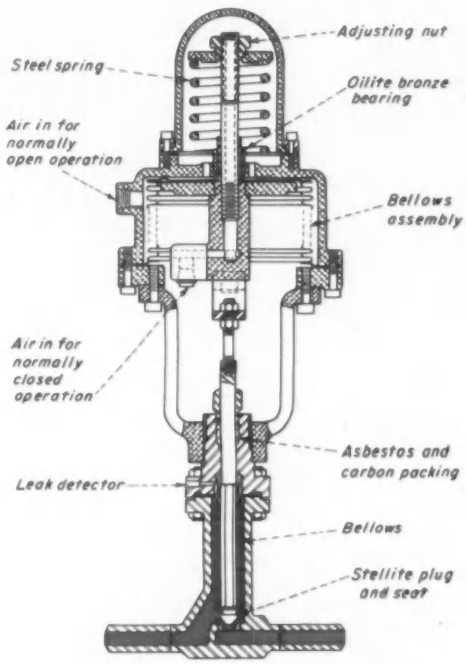
Helical-flow induction pump – This pump is similar to the linear induction pump in principle: the fluid, however, is contained in a hollow cylindrical duct rather than in a flat duct of rectangular cross section, Fig. 12. The helical-flow type is usually more compact than a linear pump of the same rating but about 50 per cent heavier. The operational characteristics and cooling requirements are similar. The two differ in that the helical type usually requires a frequency less than 60 cps for optimum efficiency.

Faraday types – This is the most elementary of all the electromagnetic pumps and has the simplest construction, Fig. 13. The fluid is contained in a thin-walled duct, usually of rectangular or square cross section, which is located in a constant field. Current is forced through the fluid in a direction perpendicular to the direction of field and the direction of flow. The current is conducted into the fluid by electrodes which are normally brazed to the walls of the duct.

Efficiencies of about 50 per cent have been obtained, and theoretical analyses have indicated that higher efficiencies should be possible. This type inherently has a low characteristic input impedance and requires a very low-voltage, d-c power source.

D-c Faraday pumps are usually equivalent to helical-flow induction pumps in weights but are more bulky. Flow control over a wide range can be obtained by voltage variation. The unusual power requirements, however, are a handicap; the difficulty of supplying very large currents, plus the sheer bulk of busbar work to carry them, have prevented the use of this type in applications where capacities of less than a few hundred gallons per minute are required to be pumped.

Valves



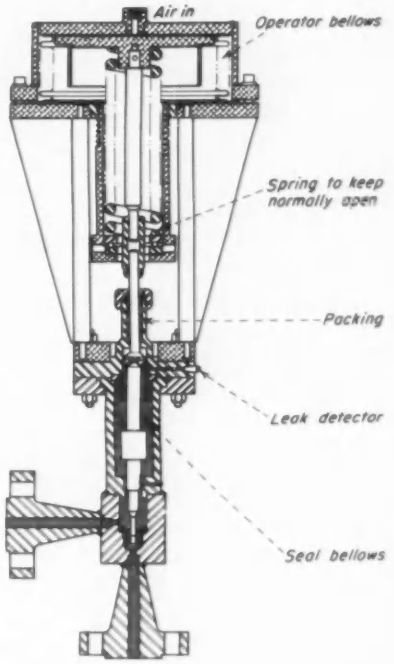


Fig. 14—Aqueous fuel system valve of Fulton Sylphon Co. design using stainless steel bellows. Lapped stellite plugs and seats provide essentially leak free closure. Maximum leakage rate of 1cc per day at 1,000 psi pressure drop across the valve is possible. In this design, the plug aligns itself with the seat and avoids part distortion when welding into the pipe.

Fig. 15—Metering valve by Belfield Co. incorporating stainless steel bellows for leakage control and a bellows valve operator. Valve operator is one way system with spring to hold valve in normally open position. The valve in Fig. 14 uses a pneumatic bellows valve operator for position control with a spring that closes the valve if the air supply should fail.

VALVES USED IN NUCLEAR REACTORS are similar to conventional high temperature units. Only exception is that more attention is given to sealing the valve stem and all joints against leakage to ambient. In addition, some design work is being done to make valve parts replaceable and easing the maintenance problems.

Bellows, single or double, may be used as sealing members in liquid metal and other systems. High-pressure water moderated systems incorporate specially designed valves having canopy and omega seal welds.

In any system corrosion and erosion effects must be minimized and wear must be minimized to prevent metal particles from contaminating the fluid and so becoming radioactive. Thus material selection becomes extremely critical in valve design.

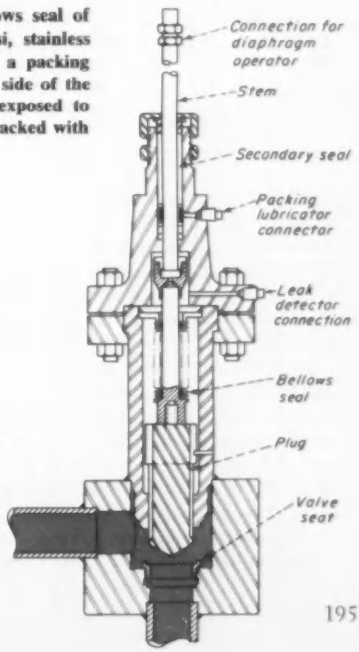
Special high temperature packing for valve stems have been developed and improve the leakage problem. One packing consists of successive layers of Inconel braid, graphite, nickel powder, and another layer of braid.

Experiments performed on bellow-type, stainless steel valves indicate that they are probably one solution to most liquid-metal and aqueous reactors. Two or more bellows in series is one method of guarding against a failure, and special pickup devices can be included to indicate a leak in either bellows. Dependability, at present, is limited owing to the statistical probability of premature bellows failure.

Bellows tests have indicated:

1) Failure usually occurs at the

Fig. 16—Single-seat angle valve with bellows seal of Belfield Co. design. The weld-in, 1000 psi, stainless steel bellows, in all figures, is backed by a packing gland and is mounted on the low pressure side of the seat. Under normal operation bellows is exposed to essentially atmospheric pressure. Gland is packed with hydrocarbon-free graphited asbestos.



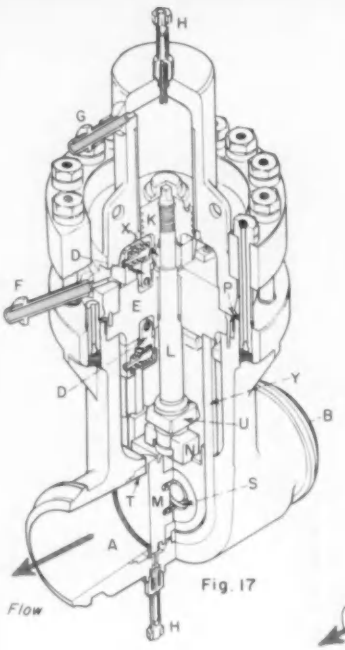


Fig. 17

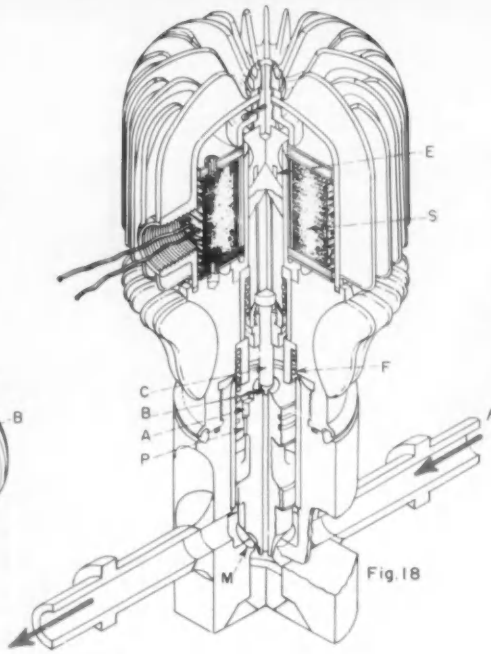


Fig. 18

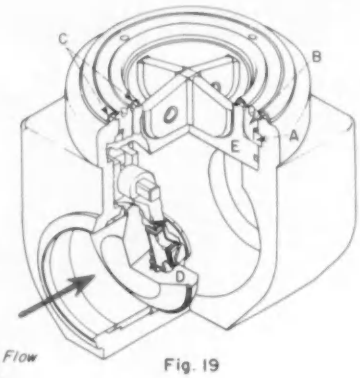


Fig. 19

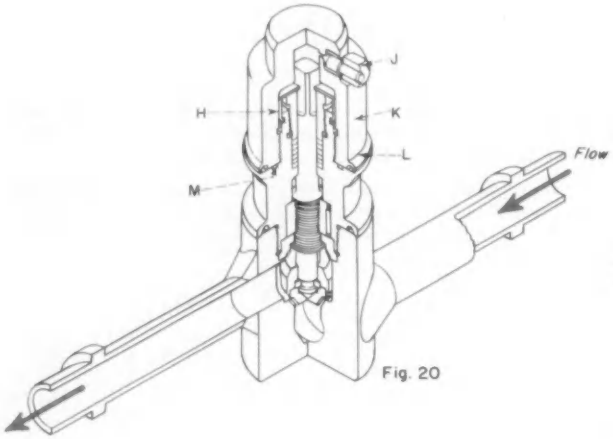


Fig. 20

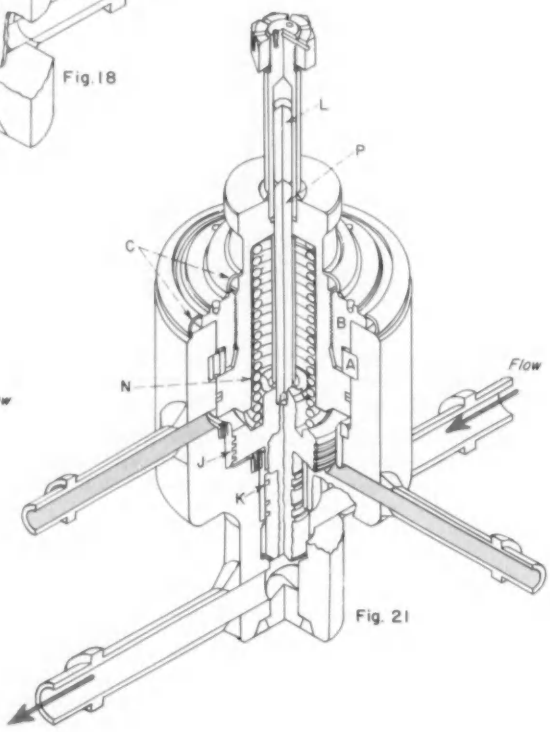


Fig. 21

Fig. 17—Cylinder gate valve, Westinghouse Corp., used as the main stop valve and located between the reactor outlet and the boiler. Normal operating conditions are 2500 psi at 450 F. Handles fluids at temperatures ranging from 40 F to 600 F. Position indicators, *H*, at top and bottom of valve are for remote indication of gate assembly position.

Fig. 18—Alternating current solenoid poppet valves of Westinghouse Corp. design for the remote control of main loop valves. Unit is made of ½ in. high-pressure stainless steel piping. Large cooling fins prevent overheating. Valves are designed for vertical mounting so that maximum air circulation is obtained.

Fig. 19—Swing check valve manufactured by Westinghouse Corp. to prevent black-flow into the pump. Fluid flows through valve from left to right holding the disc *D* in the open position. When flow stops, the weight of the disc causes it to swing close. The greater the back pressure, the tighter the valve closes.

Fig. 20—Capped manual valve designed by Westinghouse Corp. Operation is accomplished with a wrench or handwheel after cap is removed. A locking cup *H* positively retains the stem from motion caused by system vibration. Stainless O-ring *M* provides a seal between the valve and atmosphere if canopy *L* is not seal-welded.

Fig. 21—Cylinder operated Westinghouse Corp. globe valve used to close against a high pressure differential and where the valve is not accessible for manual operation. Position indicator *L* is for remote indication of the disc position. Leakage passed the disc and piston is prevented by the piston rings *K* and *J*.

weld; therefore, bellows should be examined for cracks and other forming flaws.

2) Corrosion was never a contributing factor in any failure. Stellite-face seats and poppets should be used; bellows and valve body are constructed of stainless steel.

3) Predominant factor determining bellows life is the relative amount of travel.

4) Other factors affecting life are temperature and relative distribution between compression and extension.

Several valves required for an aqueous reactor and using bellows are shown in Figs. 14 through 16. These units are typical of bellows-type valves.

Valves designed for a water-moderated reactor are shown in Figs. 17 through 21. These include a cylinder gate valve, poppet valve, swing check valve, capped manual valve and a cylinder operated globe valve.

In service, the valve shown in Fig. 17, has the primary coolant piping welded to ports *A* and *B*. Flow through the valve is controlled by the position of the two discs *M*, held within the plate *N*, and spring loaded against body seats *T*. The gate assembly is raised and lowered by piston *K*. High pressure water from a source other than the primary loop enters through port *F* or *G* to raise or lower the piston. Plate *E* serves to guide the stem *L* and to separate the pressure chamber under the piston from the main valve body. Four spring-loaded latches *D* are used with mating parts *X* and *U* to retain the stem in either the open or closed position. A horseshoe-shaped guide *Y* maintains alignment of the gate assembly with the body ports. To seal the valve, a canopy *P* is constructed between the cylinder *J* and the main body.

The pilot poppet valve, Fig. 18, uses a piston arrangement with an orifice *A* through the piston *P* to permit the balancing of pressure. Energizing the solenoid *S* opens a small pilot valve *B* to relieve the pressure above the piston more rapidly than it can be replenished through the orifice. The differential pressure created causes the main valve *M* to open. A shading ring *E* reduces chattering of the a-c solenoid. De-energizing the solenoid causes the pilot valve stem *C* to close and pressure above the piston builds up. This pressure along with the spring *F* above the piston, forces the main valve closed.

A-c solenoids have a number of advantages over d-c designs now used. Less heat is generated; in-rush current of the a-c coil produces a higher closing force across any gap in the magnetic circuit, but when the gap is closed, reluctance increases to limit the holding current to a low value.

Swing check valve, Fig. 19, incorporates a shear ring *A* to secure the valve cap *E* to the body rather than a bolted and screwed closure. This design reduces the weight and space requirements. A threaded keeper *B* prevents disengagement of the segments from the body. Separate canopies *C* are seal-welded over the joints to prohibit leakage to the exterior.

Capped manual valve, Fig. 20, has a stainless steel cap *K* that encloses the bonnet and seals against the body so that any leakage through the packing or around the bonnet connection will be entrapped. Plug *J* relieves the pressure within the cap prior to its removal.

The seating surfaces are stellite, while the valve body and cap are stainless steel. The valve stem is Haynes Alloy #25 and the insert is stainless steel. This combination has proved satisfactory for wear.

A cylinder operated globe valve is shown in Fig. 21. This valve operates similar to the gate valve of Fig. 17. In addition, however, if the controlling fluid supply should fail, the valve would be closed by the spring *N*; a fail-closed assembly.

A shear ring *A* is used instead of a screwed or bolted closure to reduce weight and space requirements. The shear ring is essentially a segmented key. Threaded keeper *B* prevents the ring from disengaging. Canopies *C* are seal-welded to prevent fluid leakage.

Seals

REACTOR CONTAINERS are penetrated by control rods, piping, and instrumentation lines. All such penetrations must be sealed to prevent the entrance of air to liquid metal systems, Na and NaK, and the exit of radioactive gases and coolant fluid in other systems.

The prevention of leakage at seals and joints is the major reason for the high cost of components such as heat exchangers, pumps and valves. The difficulties lie in the rapid deterioration of ordinary seal, packing and gasket materials by chemical action and high temperature.

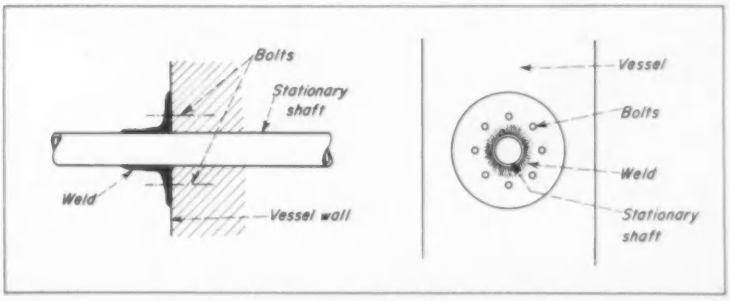
Control rods and similar items are either reciprocating or rotating. Piping is stationary. Seals are designed for either static or rotating operations.

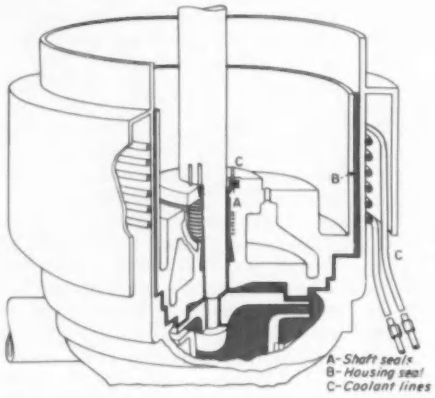
Welded Seal – For positive static sealing the welded type is most economical, Fig. 22. The disadvantage is removal. General practice is to rely upon bolts for mechanical strength and to weld the thin lips of the seal to the stationary element. Low welding temperature is required so the body of the metal is not heated excessively.

Frozen Seals—To seal either rotating or static member in liquid metal systems, a freeze seal, Fig. 23, offers a simple and economic method. The principle is to form a barrier between the internal system and the outside by freezing a slug of the process liquid metal in a narrow passage. The frozen metal is held in the passage—usually an annulus—by friction and adhesion.

Pumps require the most extensive modification of any of the commercial equipment. Two freeze seals are needed, one rotating and one static. As shown in Fig. 23, extension sleeves are added to the head and case which form a narrow annulus removed from the liquid metal. A cooling jacket placed around the outer jacket provides cooling to form the static seal. This design permits the bolting for the two parts to be placed in the cool region above the seal. A separate liquid coolant gland is inserted in the stuffing box and

Fig. 22—Welded seal is used where no motion is met, such as piping, encased control rod or instrumentation lines. Motion may cause the weld to fail. Liquid temperature passing through piping must be kept below the liquidus point of the flux material.





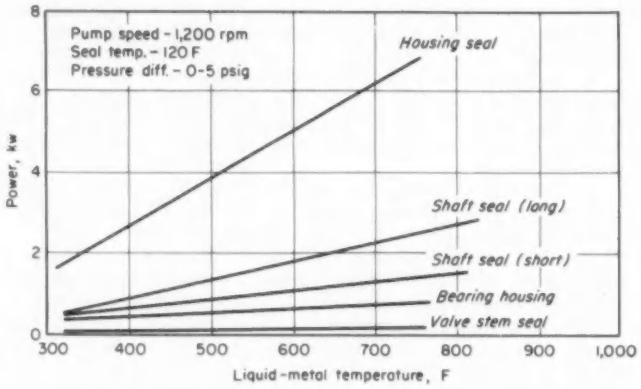


Fig. 23—Freeze seals are easily adaptable to pump and valve shafts in vertical setups. Gas leakage in horizontal shafts may be met because of cold shuts. Standard shaft finishes are satisfactory. Wobble and vibration should be less than 0.001 in. total indicator reading to avoid plastic working of the frozen metal and thereby cause extrusion or frictional heat generation.

Fig. 24—Cooling load for freeze seals. Pump bearing housing cooling load is shown for comparison. Cooling requirements vary according to seal length, pressure differential between inert gas and liquid metal, and thermal conductivity of seal material.

provides cooling for the rotating seal.

In a rotating seal, the frozen metal is continuously sheared at the shaft surface and a thin high viscosity liquid film is maintained at the shear interface. Friction energy probably supplies the heat necessary to maintain the liquid film. The high thermal conductivity of the frozen metal permits rapid heat removal so that the film does not become thick enough to allow leakage. The curves of Fig. 24 shows representative data for sodium freeze seals of various designs.

Rubber Boot Seal – Seal system is used for static and limited rotating shafts, Fig. 25. The rubber boot is a cylindrical piece of Type–GN Neoprene rubber of about 40 Durometer hardness. One end is bonded to the shaft, the other end is bonded to the container. To enable the rubber boot to withstand a differential pressure on either side, metal rings are added for support. Ring surface in contact with the rubber is rounded and chrome plated to reduce friction and wear between the rings and boot. To enhance the bearing sliding characteristics between adjacent rings during twisting of the boot, alternate rings are made of bronze; thus a bronze-plated steel bearing surface exists between rings lubricated with molybdenum disulfide.

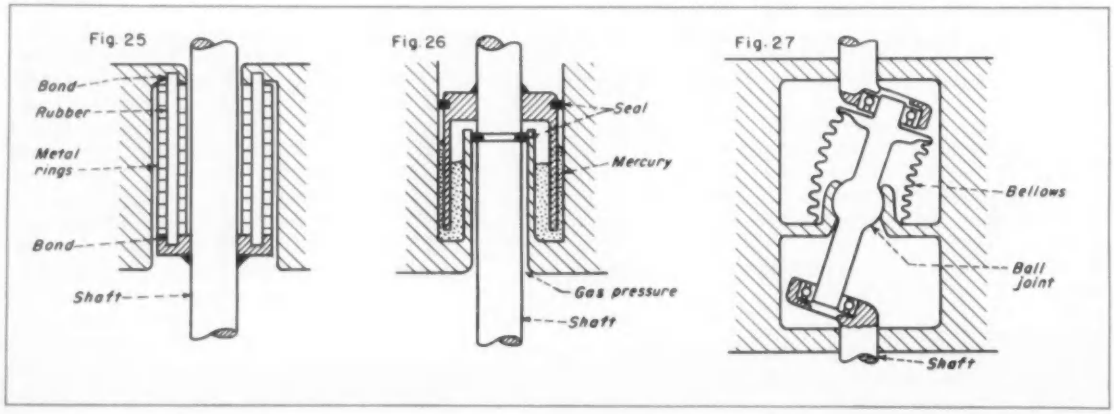
Liquid Trap Seals – A positive diffusion-free seal constructed of standard components and a trap, Fig. 26. The trap may be filled with mercury or other liquids of extremely low gas diffusivity. A seal in the form of a manometer will seal against low pressure; higher pressures can be sealed by a combination of liquid and a conventional sealing member.

Wobble Seals—Positive sealing of a reciprocating shaft is accomplished with a welded metal bellows, Fig. 27. Method does not lend itself to direct rotational sealing. The seal tends to be rather bulky and to have a limited torque and thrust capacity.

Fig. 25—Rubber boot seal designed for 140 deg of rotation. Helium blanket is confined between the liquid metal level and the seal to prevent sodium from reaching a level at which it would freeze. Two rotating O-rings are used in series with the boot.

Fig. 26—Liquid trap seal for rotating shafts. Mercury and seal prevent the entrance of air or the escape of liquid metal or fluid. Seal material dependent upon temperature and chemical action of internal liquid. Outer seal rotates with the shaft.

Fig. 27—Wobble seal may be designed to take rotating motion. Rotational motion is converted into a wobble or a reciprocating motion, passes through the bellows, and then converted back to rotational motion. Seal has limited torque and thrust capacity.



Bearings and Lubrication

IMPORTANT FACTORS in the design and operation of bearings under conditions unique to nuclear systems are: the compatibility of the bearing materials; friction; stability under irradiation; ease of manufacture; high pressures and temperatures; and the desirability of small pressure losses in the system external to the reactor.

Proper material selection can minimize or eliminate many of these problems. Two materials that give satisfactory service in liquid metal systems for intermittent, light load service are Type 138A Kennametal on 779 Carboly. Bearings of these materials have been run in sodium at 850-950 F under a loading of 50 psi with good results. Maximum friction coefficients were 0.31 running and 0.53 static.

In light and heavy water reactors, boiling water reactors and certain other reactor types, water is used as the bearing lubricant. The bearings are of the sleeve or hydrodynamic design. Sleeve bearings are usually constructed of graphite. The hydrodynamic bearing types are constructed of a material suited to the component application. With these bearings contact with the rotating member is limited to starting and stopping. A sleeve bearing may be needed to carry the loads during stopping and starting of the system.

Journal Bearing – One design is shown in Fig. 28 and considers the problems of thermal stress and misalignment between materials.

Since the bearing material differs from the structural material, differential thermal expansion between the materials could result in severe thermal stresses. This effect is eliminated by using conical surfaces. Any dimensional change produced by temperature variation is radial from the shaft center line. Tightness, as a result of relative thermal expansion, of the bearing in its support is constant. The only stresses caused by differential thermal expansion between the bearing and shaft will be sliding stresses at the interface. This stress is caused by the relative expansion between the bearing material and shaft material.

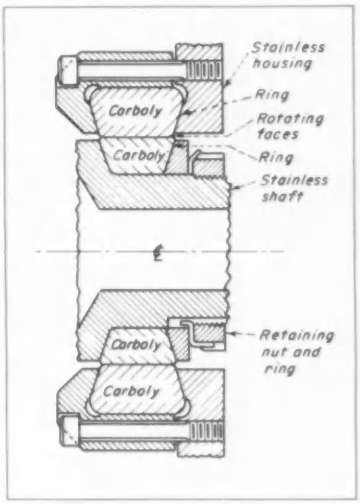


Fig. 28 – Journal bearing design. Conical surfaces permit radial expansion of bearing and support caused by temperature variation. Convex inner bearing surfaces permit bearing misalignment at low contact stresses. Design gives 0.0135 in. to 0.0145 in. diametrical clearances on 4.5 in. contact diameter.

To minimize the effects of misalignment the inner journal bearing surface is slightly convex. Small misalignment is possible with only a small amount of curvature (less than spherical); a spherical surface produces higher contact stresses but are capable of large amounts of misalignment.

Anti-Friction Bearings – Ball and roller bearings can be used if they are constructed of materials that remain hard at high temperatures, such as 18-4-1 tool steel. Their design should minimize sliding among the various parts of the bearing on each other. To accommodate axial and angular misalignment Fig. 29 shows several bearing designs of various companies.

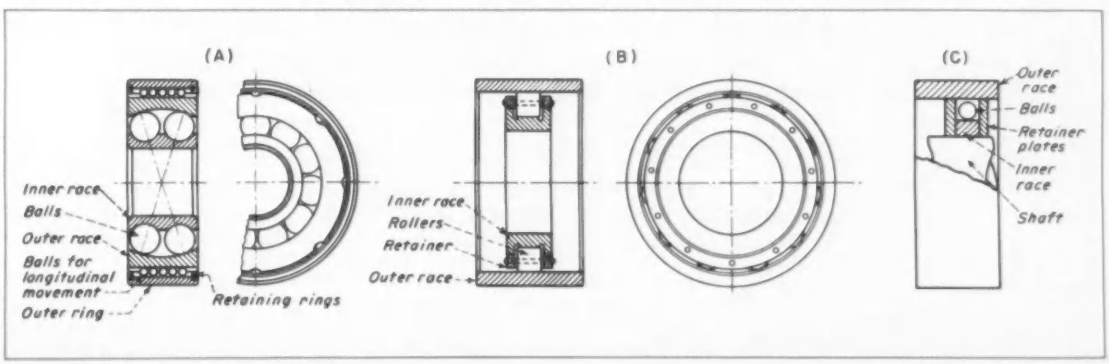
For small-angle oscillations, conventional needle bearings of 18-4-1 tool steel have been successful.

Bearing Lubrication—Pumps, valves, compressors, turbines and other components have been designed that use oil, water, gas, liquid metal, to successfully lubricate sleeve, roller, ball or needle bearings. Method of lubrication often depends on the reactor system.

Two types of shaft bearings that have been considered for a gas cooled system are: oil lubricated and gas operated bearings. The oil lubricated type requires an effective seal to prevent contamination of the gas coolant by the lubricant; the gas type, using helium from the system as the actuating medium, completely controls the contamination problem.

A gas bearing (as well as a combination thrust and journal bearing) is shown in Fig. 30. The journal bearing consists of four pockets as shown in section *AA*. High pressure gas is admitted through individual orifices. Gas is discharged through the annular clearance space between the sides of

Fig. 29 – Double row ball bearing, (A). Balls between outer race and outer ring permit longitudinal movement. Roller bearing, (B). Special bearing, (C). All units are rolling contact bearings permitting oscillating service at high temperature.



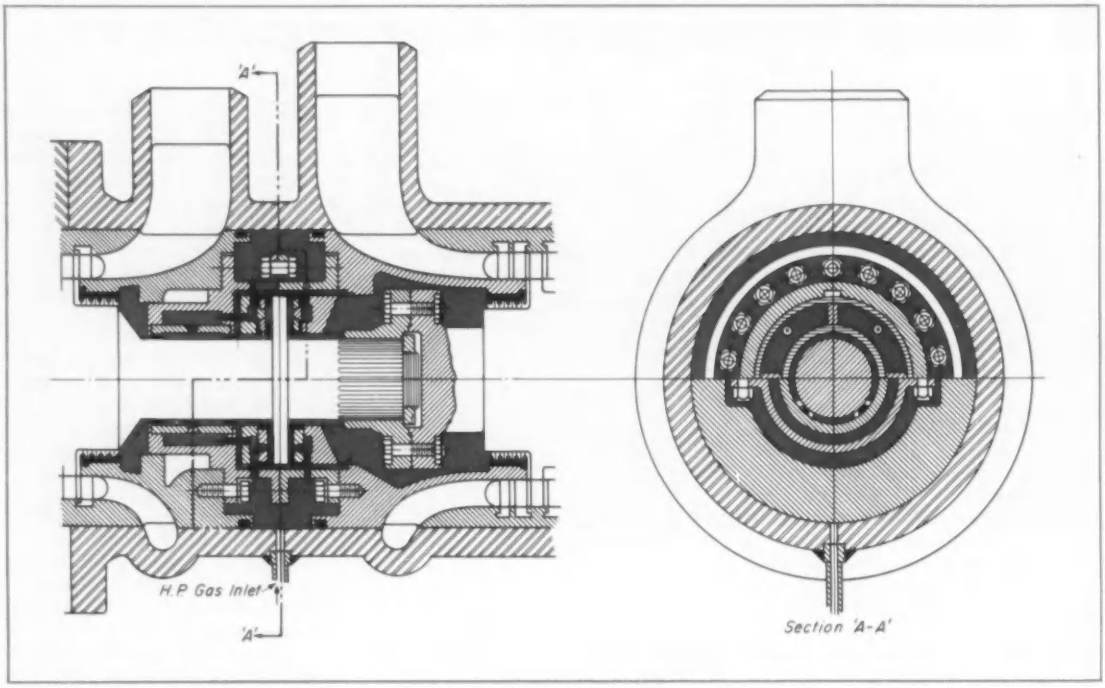
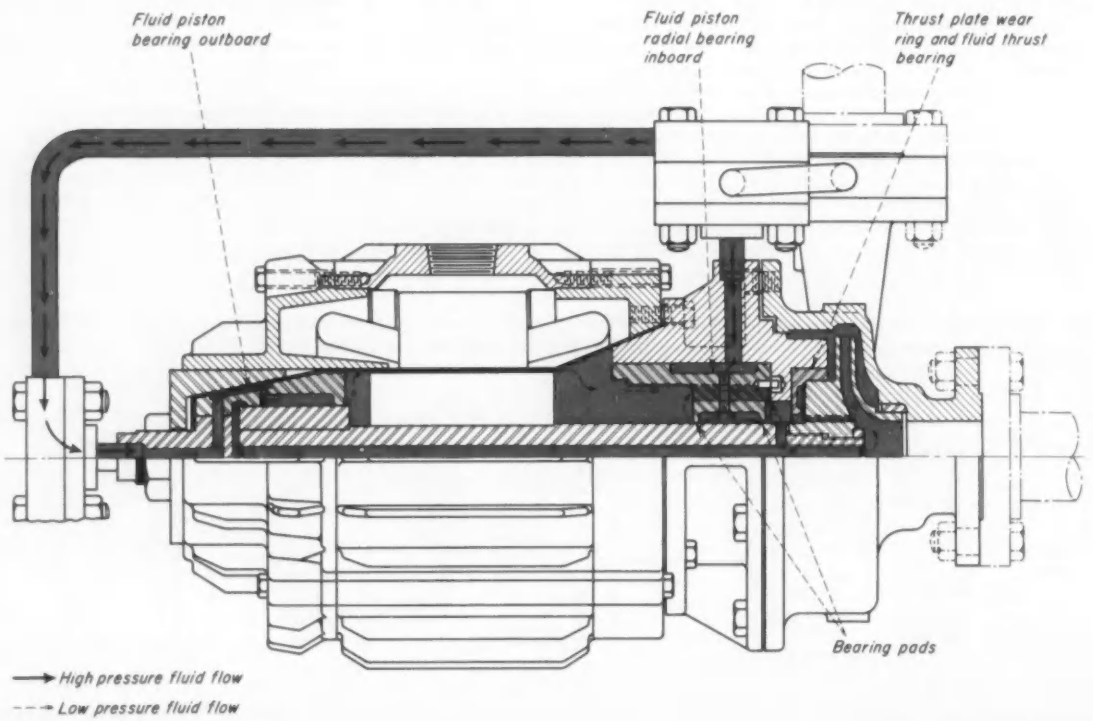


Fig. 30 — Gas bearing for gas cooled reactor. Arrows indicate flow of gas. Stepped labyrinth glands reduce leakage along the shaft. Conventional seals retain gas in annulus permitting only small leakage to outside atmosphere.

Fig. 31 — Fluid piston bearings in Allis-Chalmer pump eliminate metal-to-metal contact. Radial bearing maintains shaft alignment and thrust bearing carries motor load. Sleeve bearings have sufficient area to carry load during startup and shutdown.


Fluid piston bearing outboard
Fluid piston radial bearing inboard
Thrust plate wear ring and fluid thrust bearing
Bearing pads
High pressure fluid flow
Low pressure fluid flow

the pockets and shaft. Since leakage area from each pocket depends upon shaft position, any transverse shift of the shaft will alter the gas pressure in the pocket. A restoring force will re-center the shaft in the bearing.

The thrust bearing operates on the same principle, except the annular pockets are continuous. The gas is discharged through the clearance areas at the inner and outer diameters of the bearing.

A fluid piston radial bearing is shown in Fig. 31. Liquid is forced to the bearings, pressuring the bearing pads. Pad pressure is self-aligning, keeping the shaft aligned in the bearing. Leakage is returned to the pump. Method eliminates metal to metal contact except at starting.

Axial thrust towards the pump suction end is balanced by hydraulic force that is created by having the front wear ring smaller in diameter than the back wear ring. Axial thrust towards the motor end is carried by the thrust plate wear ring which combines the wear ring and fluid piston thrust bearing. Pumped liquid enters the bearing pad on the thrust bearing through the back wear ring clearance. Thrust bearing leakage is returned to the pump section. Metal to metal contact thus exist only at startup and shutdown.

An oil lubricated journal for a gas cooled reactor system is shown in Fig. 32. It consists essentially of the bearing with an oil seal and a gas baffle on each side. An oil tank, oil cooler, and contaminated-gas discharge pump are sealed into the system. Oil is supplied to the bearing by the pump and discharged into an annular space around the bearing; then back to pump and cooler and return to system.

A small positive-displacement pump on the same shaft as the oil pump is used to meter a small quantity of gas through the gas baffles. This gas picks up any oil leakage by the seal rings and delivers it to a separation point.

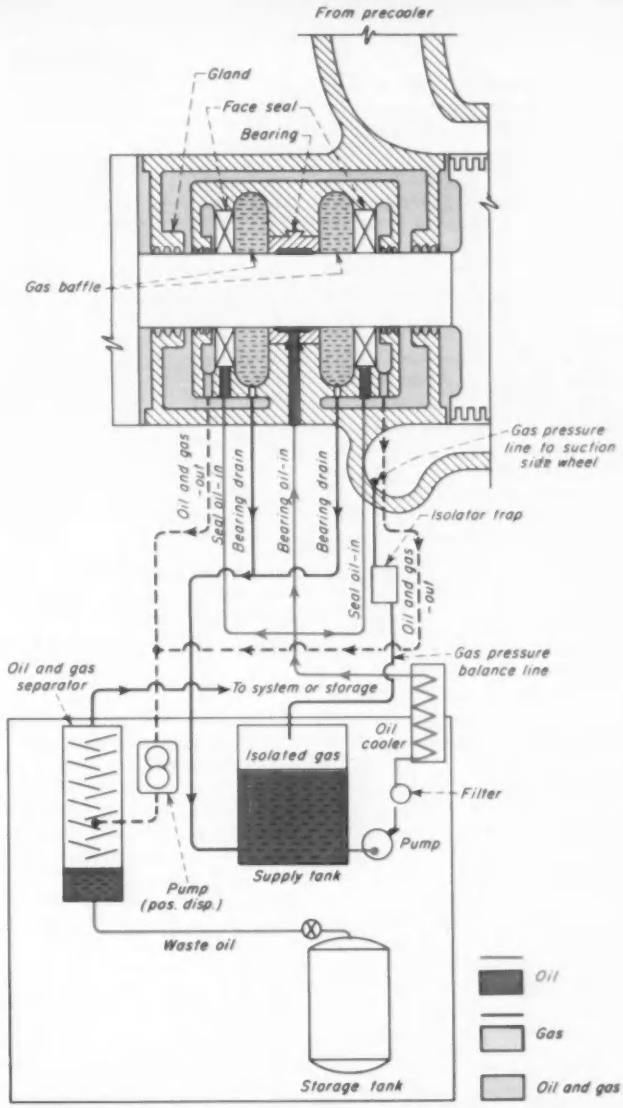


Fig. 32 — Oil lubricated journal bearing system for gas cooled reactor. Separate oiling system is used for each bearing because of different pressures imposed on different parts of the system. The quantities of oil and gas removed are small because of the low pressure differentials involved. Oil loss is about 40 cc/hr per seal.

Instruments and Controls

THE TERM, CONTROL, as applied to a nuclear reactor, refers to devices for changing reactivity and regulating reactor neutron density or power. Instrumentation generally applies to neutron-sensitive units. Instruments handle the instrumentation data and feed it to the over-all control system. Fig. 33 shows a generalized nuclear-reactor instrument and control system.

The controlled variable is average neutron density. This quantity, n (neutrons per cu cm), is a direct measure of reactor power production. The product of n and the neutron velocity, v (cm per sec), is the average neutron flux nv. This is the quantity measured by a neutron-sensitive instrument near the reactor core, in the reflector, or in the shield. The absolute value of flux at the instrument determines the electrical current from the instrument and is a measure of average neutron density when the element is calibrated against the average reactor power indicated by coolant temperature rise and flow rate.

The control variable is k or δk in which k is a value of the thermal-energy neutrons produced per thermal-energy neutron absorbed. A reactor is critical when the neutrons produced are greater than the neutrons absorbed. In starting a reactor or in maintaing a power level the rate of change and the magnitude of neutron density are

observed. Automatic protective electrical circuits limit these values and shut down or scram a reactor if a maloperation exists. Mechanical and electrical interlocks are used to prevent damage to the control-means drive motors and to prevent improper operating sequences.

Control Rods – These units control the power level of a reactor. Rods may be classified as safety rods, shim rods, regulating rods and shim-safety rods. Each has a specific function but all may not be used in any one reactor. Some operations may be combined.

Safety rods are generally moved at a uniform rate through their entire stroke. Their removal to a predetermined position activates the reactor to a position just below critical. For safety, scram action is through stored energy sources, such as gravity or springs. They are securely held in the "ready" position by a quick-release, fail-safe device, such as a holding electromagnet or electromagnetically operated latches.

Shim rods are generally positioned by means of a rack and pinion, lead screw and nut, cable hoist and similar devices. The primary driving motor may be hydraulic or electrical. Electrical motors are used with differential gearing and brakes to provide reliable, very-wide-range speed adjustment. Scram action should be positive.

Regulating rods are similar to shim rods. Continuous, accurate positioning is necessary. Rod should be held stationary by a mechanical brake when not being moved and guided when in operation to prevent vibration.

A shim-safety rod combines the functions of shim and safety rods. It must position accurately for shim action and move rapidly for scram action when acting as a safety rod.

A typical rod drive mechanism is shown in Fig. 34. Unitized design permits mechanism to be used for any of the rod types. For a regulating rod drive, servo controlled, a servo motor is selected to fit the worm reducer unit. For a shim-safety rod drive, a standard motor can be used and appropriate gearing assembled in main transmission to drive the rack.

A rod drive using a ball worm and

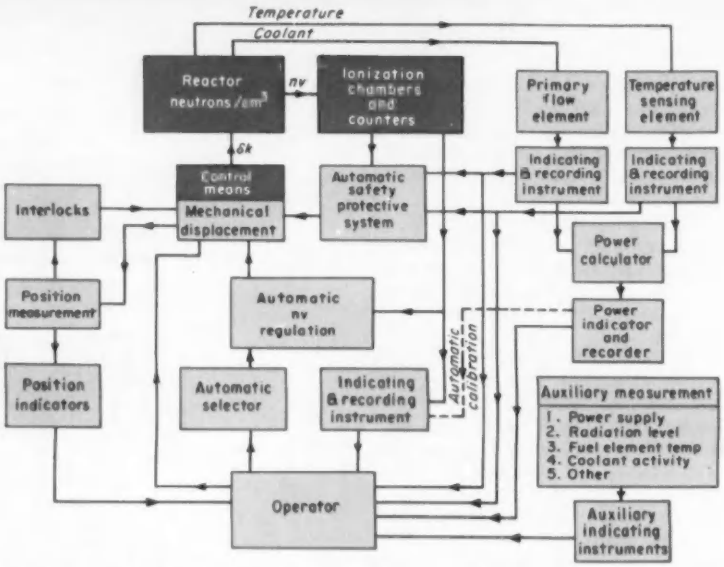


Fig. 33—Generalized reactor control block diagram. Fast changes in power are measured with flux sensitive instruments in fractions of a second. Coolant power measurement is slow, sometimes a matter of minutes. Automatic systems prevent dangerous power buildups and take over on tedious prolonged operations at fixed power.

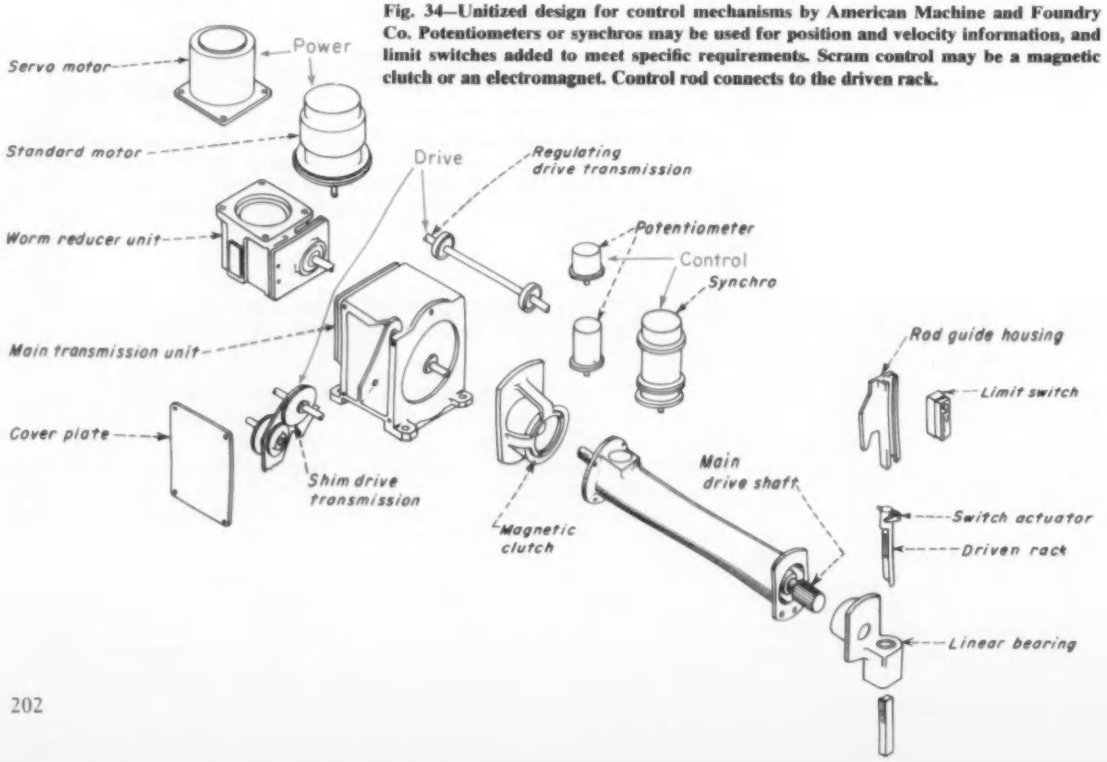


Fig. 34—Unitized design for control mechanisms by American Machine and Foundry Co. Potentiometers or synchros may be used for position and velocity information, and limit switches added to meet specific requirements. Scram control may be a magnetic clutch or an electromagnet. Control rod connects to the driven rack.

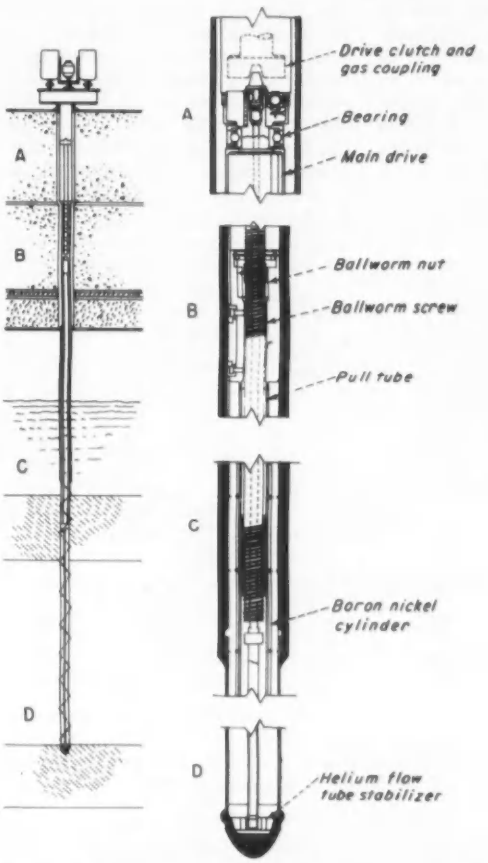


Fig. 35—Ball nut screw arrangement for control rod motion. Pull tube is attached to nut and a motorized drive turns the screw. Nut rotation is prevented by machined flutes on the thimble. Molybdenum disulfide is used as a lubricant. Haynes 25 alloy is used throughout. This arrangement appears superior to the Acme screw arrangement.

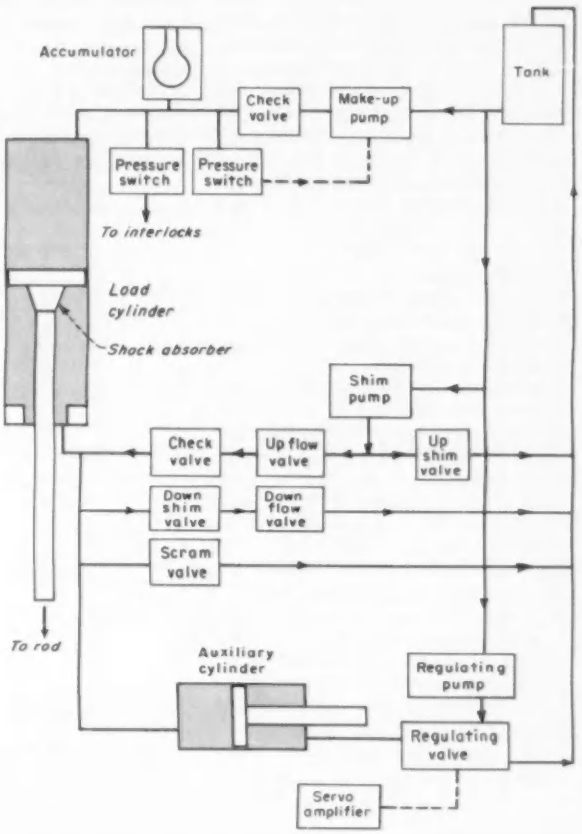


Fig. 36—Schematic of hydraulic actuator control. Make up pump and switches maintain piston position caused by leakage. Down shim valve is normally closed and when open permits downward travel at a rate determined by the down flow valve. De-energizing the scram valve opens it causing a fail-safe setup. Regulating control is by the auxiliary piston, pump and valve.

ball nut has been designed for the Sodium Reactor Experiment. The control rod is contained in a thimble assembly, Fig. 35, which extends from the top of the shield to a point just below the core, a total distance of 23.5 ft. This arrangement permits a self-contained control rod assembly in which no sodium or sodium vapors contact the moving mechanical parts. Boron nickel cylinder controls the power level. Helium gas at about 16 psig is used as an atmosphere within the thimble. The gas serves to remove heat from the cylinder and transfer it to the sodium coolant on the outside of the thimble assembly.

Hydraulic reactor controls have also been designed. Fig. 36 shows a schematic of such a unit. They should be considered for applications involving large forces, rapid response and limited space. The question of leakage and drift is critical and should determine to some extent the type of system chosen as well as basic design constants for the hydraulic system.

Automatic Systems — A reactor is protected from damage by a system of electrical interlocks, sensing elements, relays and instruments. In general, protective system elements are designed to fail-safe, either by deactivating a protective circuit and setting off an alarm or causing the control rod to reduce the power level. Listed are some conditions which are considered dangerous and some instruments used to measure the conditions:

1. Neutron density 150 per cent of normal density. Measuring is done with various types of primary elements, such as neutron sensitive ion chambers, gamma chambers, pulse counters, scintillation counters and neutron thermopiles and others.

2. Flux period less than one second. Neutron-sensitive ion chambers and pulse counters are used as sensing elements for measuring this condition.

3. Excessive coolant temperature. Measured with thermocouples, resistance thermometers, and gas or mercury bulbs in the coolant stream.

4. Rapid changes in coolant temperature. These changes are indicated by attaching amplifiers and rate circuits to the coolant temperature instruments.

5. Loss of instrument electrical power supply. Under-voltage relays both time-delayed and instantaneous are used. For increased reliability, instruments are fed by battery driven d-c motors and a-c generator sets. The battery is, in turn, floated on an a-c motor and d-c generator combination driven from the purchased power supply or possible other power source.

The monitoring of the system based on the values picked up by the primary instrument elements of dangerous conditions has led to the development of unique and improved instruments and controls. Some examples follow.

A block diagram for cooling water monitoring is shown in Fig. 37. A transmitter, Fig. 38, measures the differential pressure across each orifice and sends a proportional 60 cycle signal to the control room.

Here, signals from the transmitters come into a bank of selector switches which automatically step from one transmitter to the next. The output from each transmitter is switched simultaneously to an instrument which records the reading and into a low flow detector that operates a horn and light. To identify the channel in which flow reduction is detected, a large board with a separate light for each channel is used. A second bank of selector switches, mechanically connected to the first, permits the low flow detector to light the proper bulb.

If flow is further decreased, a limit switch mounted on the transmitter closes, automatically scraming the reactor. Each limit switch operates a light indicating the malfunctioning channel to ease circuit checking.

A temperature monitoring block diagram is shown in Fig. 39. The temperatures of cool incoming water in the main header and of hot water leaving each channel are measured by thermocouples. Units terminate at an isothermal junction box and copper extension wires lead to the banks of stepping switches in the control room. Temperature rise in each channel is the difference between header and the channel valves at the reactor.

If temperature rise in any channel varies from a normal setting an alarm sounds. Since the normal temperature rises in the channels differ, the monitor has an alarm set point for each channel. This is accomplished by an

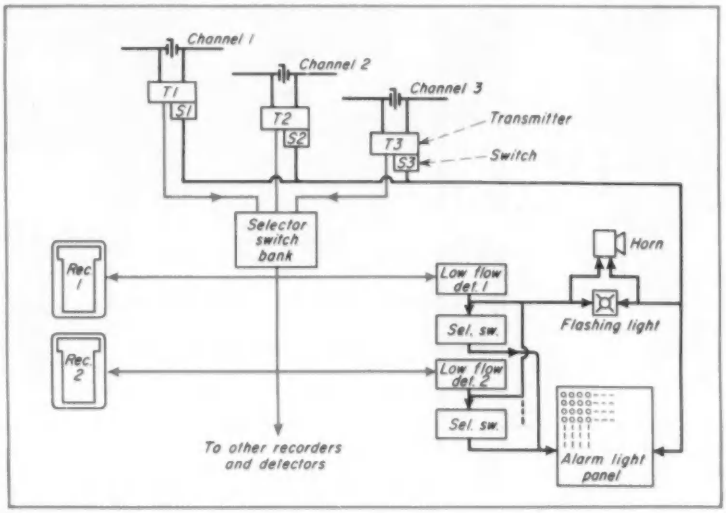


Fig. 37—Cooling water monitor. Small reductions in cooling water flow could cause local overheating. A large reduction necessitates an immediate shutdown.

Fig. 38—Differential pressure transmitter. Increase in pressure causes diaphragm to move upward moving the primary beam about the cross-spring pivots. Motion is opposed by a cantilever spring. Movement of the spring positions an iron slug in the center top coil, changing the inductances of the coil halves which are two arms of a wheatstone bridge.

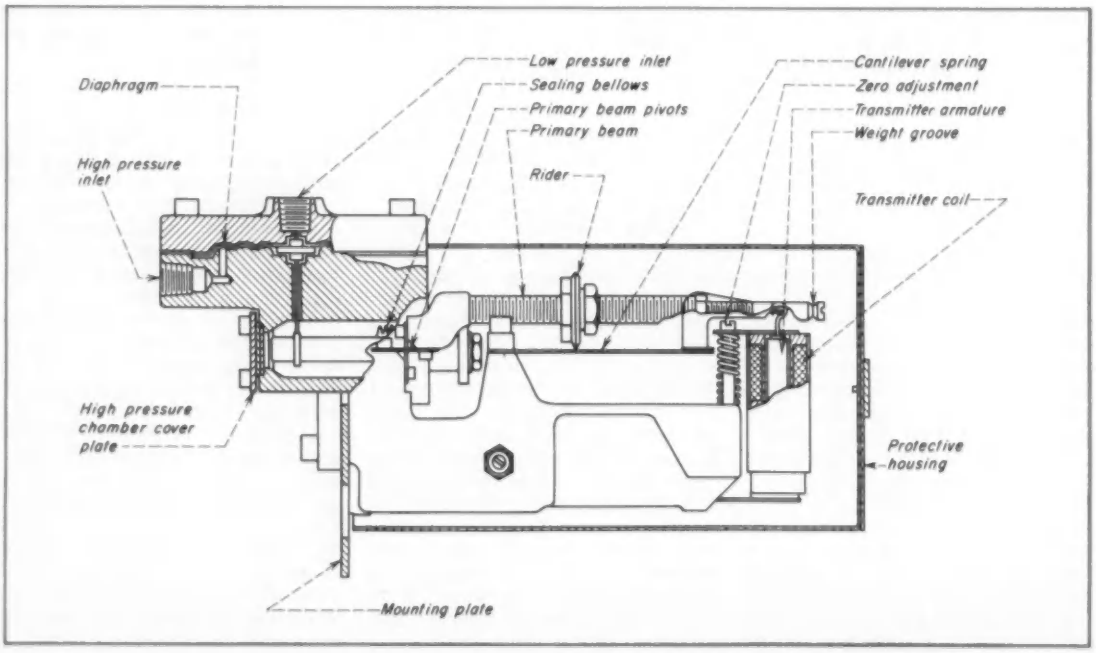
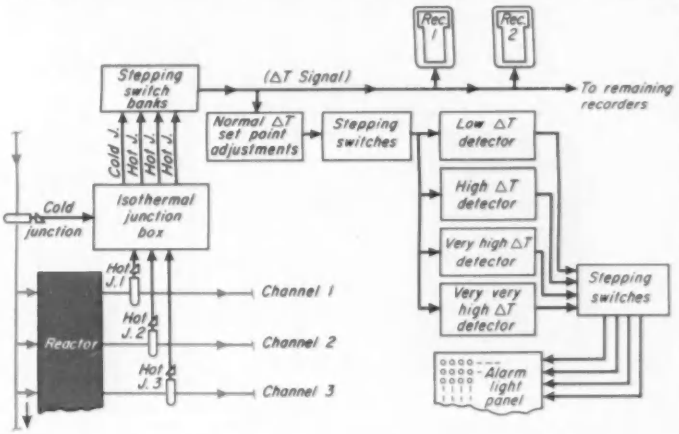


Fig. 39 – Temperature monitoring system. Normal temperature rise is dependent on the power level, therefore, a control automatically adjusts all normal temperature rise settings to values correct for the power level of the reactor.



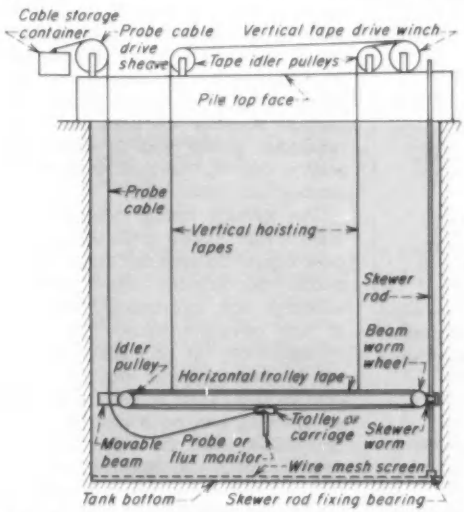


Fig. 40–Traveling monitor to obtain a profile of neutron flux distribution. Aluminum trolley, skewer rod and beam are used since aluminum does not absorb neutrons. Hoisting tapes are stainless steel.

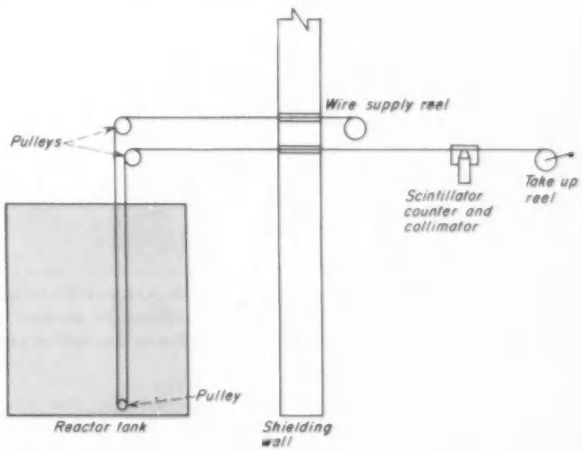
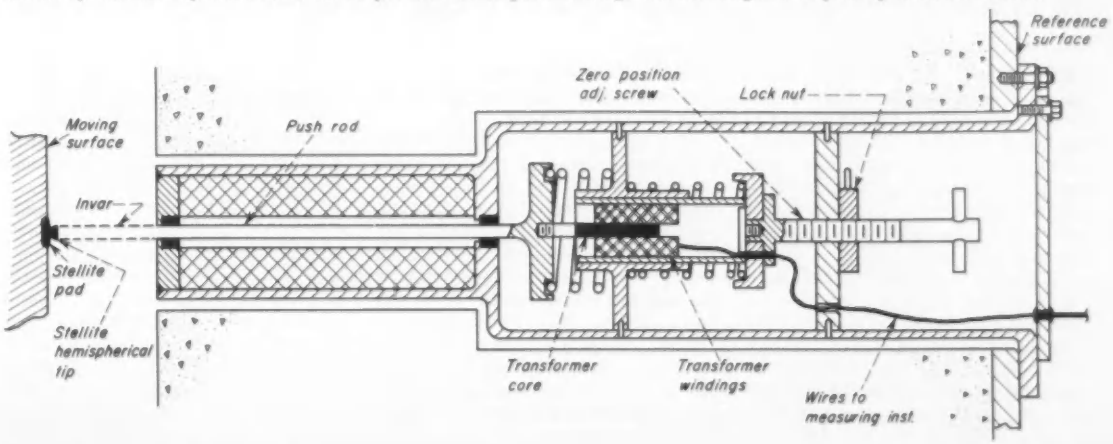


Fig. 41–Wire flux monitor. To obtain a traverse a fresh piece of wire is fed into the reactor, activated, and cranked out past the counting head. Two traverses are obtained for each activation, one for the descending and one for the ascending wire.

Fig. 42–Linear differential transformer installation. Relative motion of two parts can be measured by fixing the windings to one part and the movable core to the other. Care must be taken to eliminate relative movement of parts within the device and errors caused by thermal expansion. This device permits reactor power settings without danger of a primary structural failure.



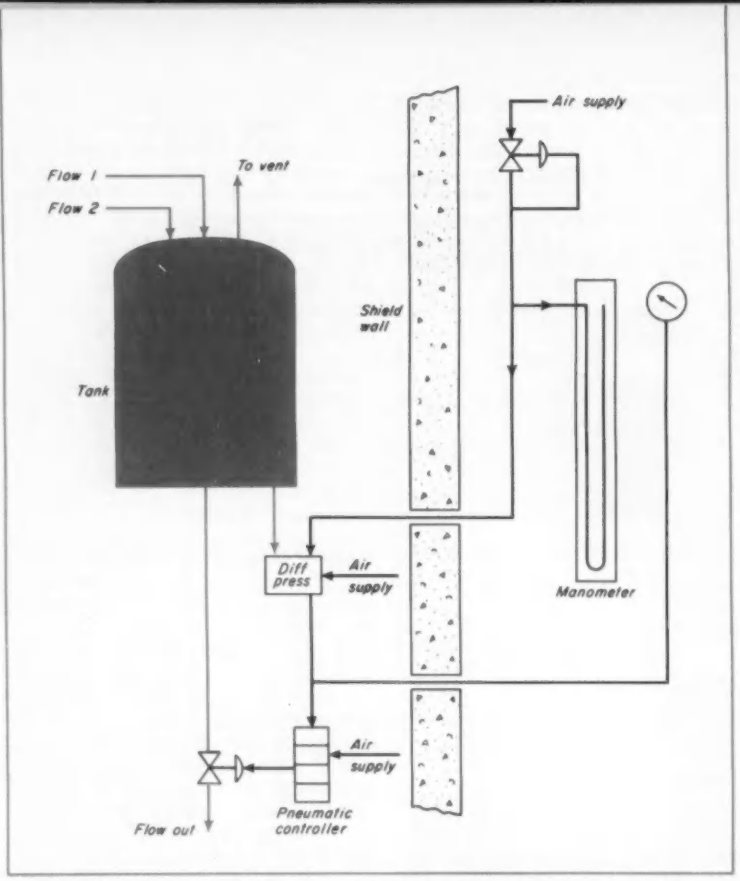


Fig. 43—Null balance liquid level control. Variations in liquid level in the tank caused by the two variable flow inlets is controlled by a differential pressure transmitter and a pneumatic controller. These units control the valve on the outflow tank line.

e.m.f. in series with each hot junction that may be adjusted to be equal and opposite to the e.m.f. between the hot and cold junction when the temperature is normal.

An e.m.f. proportional to the deviation from the normal temperature rise is transmitted via the stepping switches into four parallel alarm circuits. These automatically control the temperature by taking corrective action. A third alarm automatically scrams the reactor.

To obtain a profile of the neutron flux distribution over a reactor several probes can be used. However, this requires expensive duplication of equipment and careful intercalibration between chambers or probes. Traveling monitors, similar to the schematic of Fig. 40, can be used to minimize the expense and time factor. The beam can be moved vertically while the probe moves horizontally permitting flux readings to be taken all over the tank with a single probe unit.

Another method of finding the flux distribution is shown in Fig. 41. Wire is supplied by an outside drum. It passes through the shielding wall, over a system of pulleys into the tank and back out. The wire passes a counting head to indicate the flux level.

Linear differential transformers are used to measure relative motion between parts as an indication of internal stresses. Heat developed by the reactor varies between shutdown and full power level and causes expansion and changes in clearances between adjacent parts. The instrument, Fig. 42, permits accurate calculations of the maximum power level at which the reactor can be operated without exceeding safe stress limits.

The sensing device consists of a transformer having a moveable iron core which changes the coupling between the primary and secondary windings and consequently the ratio of input to output voltage. The output voltage from the secondary winding can be made a linear function of the core motion. Total motion of as little as 1/16 in. can be measured within ± 0.002 in. with the reference point several feet away from the moving point of the device and structure.

In a reactor system where close control of the liquid level in a tank is necessary a null balance control may be used, Fig. 43. Level is controlled by varying the effluent flow.

■ Remote Handling Equipment

THE PROBLEM OF REMOTE MAINTENANCE in homogeneous reactor systems is more difficult than in heterogeneous reactors because the fission-product activity of liquid fuels is not confined to a package. The problem, however, exists in both types since a radioactive component, part or specimen will need be handled.

The major problem in maintaining and repairing any highly radioactive equipment or in handling radioactive parts or specimens is that of preventing excessive radiation exposure to personnel. To accomplish this it is necessary to: reduce neutron activation by shielding equipment; and by giving personnel remote handling devices behind adequate shielding.

Irradiation of construction materials is a result of neutron emission inside the fuel container and neutron leakage from the reactor to external equipment. It is unlikely that emission can be prevented, although the resultant activity may be kept to a minimum by the proper selection of low-cross-section materials. Boron, for example, has a large cross section for neutron capture and relatively weak radiation after capture. It might be incorporated into construction materials to compete for the delayed neutrons that are present in the external equipment.

Assuming that all reasonable steps have been taken to prevent neutron activation of materials and to remove contamination, if the beta and gamma activity of equipment is still intolerable, personnel shielding must be used. Such shielding may be constructed of high density solid materials, or the equipment may be so designed that it can be flooded with water. Either way it is necessary that remote handling devices (see headpiece) penetrate the shield to perform the necessary operations and protect operating personnel.

Remote Maintenance Design—In the design of any equipment for remote maintenance, tools and procedures required to affect a repair or conduct a test should be kept simple. Proper spacing and arrangement of equipment is important. Bolts on flanges and joints should be large (not less than 1 in. dia), of the same size throughout, if possible and placed for easy assembly and disassembly. For instance, if the work is done from above, all bolts should be vertical. Electrical and instrument lines should have easily detachable connectors. Where fluid lines are involved, self-sealing disconnects should be used. All removable pieces, such as pumps, motors and others should be equipped with lifting eyes or yokes, properly located with respect to the center of gravity.

A group of simple tools which may be used for a syringe, cutting, removing or screwing are shown in Fig. 44. These tools are typical of those used in remote manipulators and slave arm units for the maintenance of reactors and the carrying out of tests and experiments in the reactor test cells.

Manipulators – These units are remotely controlled arms capable of gripping diverse objects and having sufficient degrees of freedom to manipulate an object to almost any orientation and position in a working volume. All movements are controlled by an operator who is outside the working volume and separated from it by a

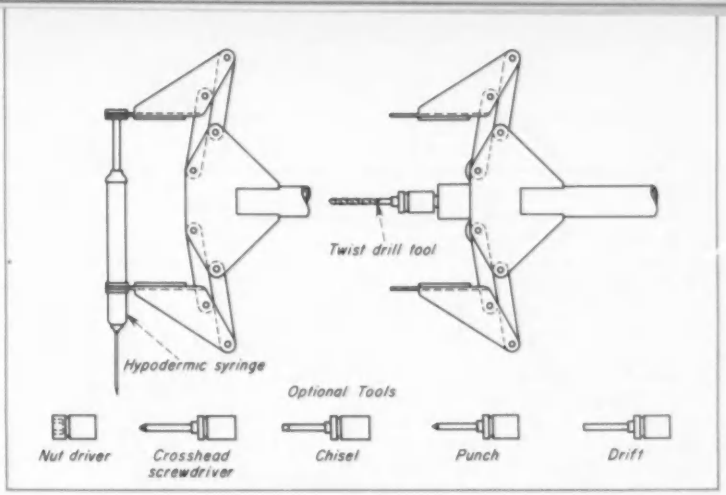


Fig. 44—Tools that can be used with a General Electric ball-joint manipulator. Tools are remotely inserted. Other types of tools that may be used with various manipulators include a operated wrench, knife for removing insulation, lifting hoists and guide pin for aligning flanges, and other pneumatic, electrical, and mechanical tools.

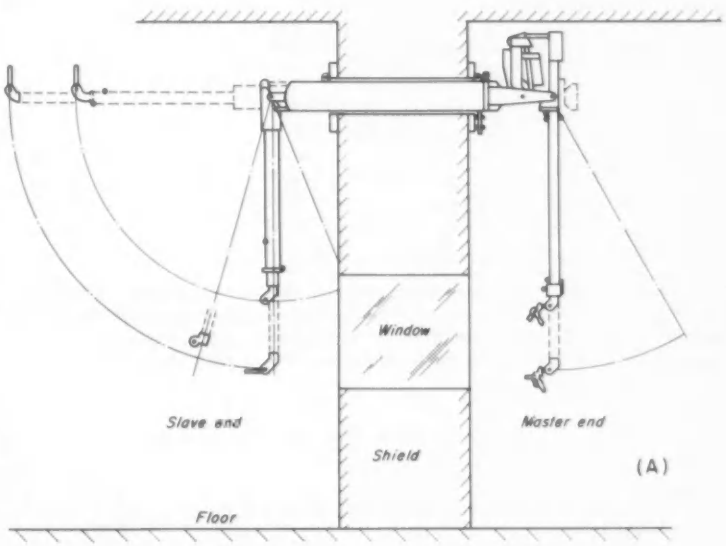
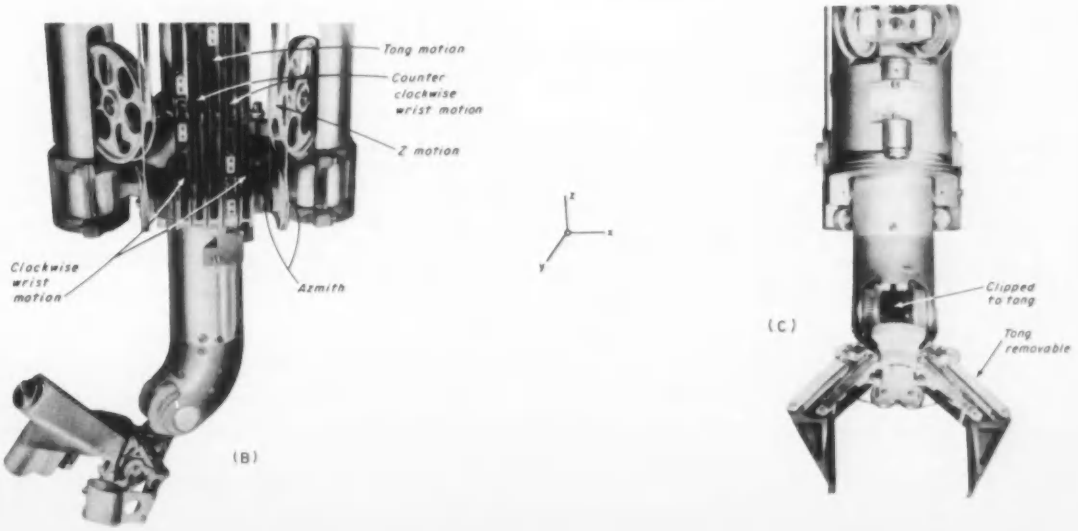


Fig. 45—Master slave arm (A) mechanically actuated produced by AMF Atomics Inc. Model will handle radioactive materials weighing between 5 and 15 lb and in certain positions up to 30 lb. (B) shows closeup of tape and cable controls. (C) the tong arrangement which is replaceable with other units.



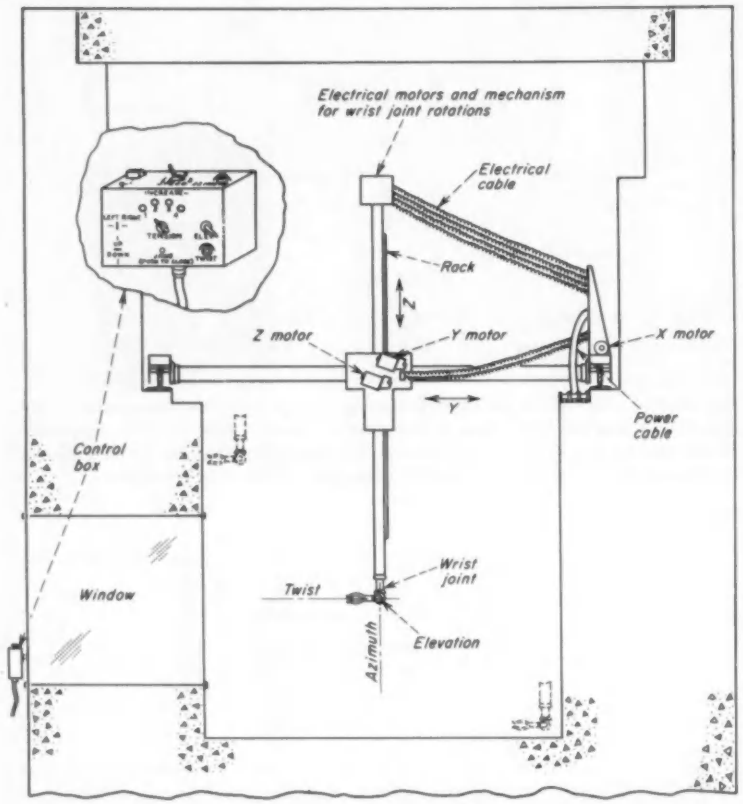


Fig. 46—Light duty manipulator designed to operate in confined spaces. The motions are driven by d-c motors whose speed and direction are switch-controlled at the control box shown. Wrist-joint and gripping drive motors are top mounted to conserve space at the joint. This allows additional motion of the wrist and grip.

shielding barrier. The unit may also have a higher, lower or the same load capacity as the human arm. Finally, it may be controlled by electrical motors, electrically-controlled hydraulic systems or by mechanical means, such as tapes and cables.

Master slave units, Fig. 45, capitalize on the natural characteristics of the operator. All motions of the slave tongs are driven synchronously in orientation and position by a single master handle. All motions have high mechanical efficiency, low inertia, low friction and are bilateral. Therefore, the position and force on the tongs are reflected back to the control handle so that the forces and torques are about the same as if the operator had the tongs and the grasped object in his hand to perform the operation.

Other types of manipulators are powered with unilateral on-off variable speed drives and are driven by electrical motor or electrically-controlled hydraulic systems. Fig. 46, shows a typical electrical unit and Fig. 47 a hydraulic system. These units can be designed for almost any load capacity and can be constructed from standard commercial components and materials for most of the parts.

Viewing – Methods presently being used or considered include: submerged viewing using water; windows having protective properties; periscopes, with or without magnifying lens; and closed loop television. Table IV lists some advantages and limitations of each.

Table IV — Advantages and Disadvantages of Remote Viewing Methods

SUBMERGED OPERATION

Advantages

1) Inexpensive and reliable as a shield and a means of viewing.
2) Only satisfactory method known for very high activity levels.
3) Open tank allows many viewers to see and work from several angles.
4) Simple, longhandled tools and grapples for rudimentary manipulations may be used.

Limitations

1) Commercial machinery and equipment not suited for underwater operation.
2) Facilities are needed for handling large volumes of liquid waste water.

WINDOWS

Advantages

1) Gamma shield equivalent of 4 ft of concrete. More if exposure is intermittent.
2) Apertures up to 5 ft sq are feasible. Considerable bodily freedom while observing is possible.
3) Normal vision is retained. Field of vision can approach 180 deg with rapid scanning.
4) For experimental work, standard commercial equipment may be used with nearly normal operator-equipment orientation.

Limitations

1) Stability of materials, other than water, is not as well known for neutron activity as it is for gamma irradiation.
2) For large enclosures, multiple viewing stations may be required. This may require multiple control stations for manipulative equipment or preclude the use of mechanically connected manipulators.

PERISCOPES

Advantages

1) For close examination of details, a large image of excellent quality can be achieved.
2) Can be used with instruments requiring eye-presence, such as microscopes or micro-hardness apparatus.

Limitations

1) Observer is closely confined to the eyepiece, which is apt to be tiring and impedes any simultaneous work such as manipulation.
2) Usual field of 50 deg or less is insufficient for overall observation.
3) Only one person at a time can see.
4) Increasing versatility also increases complexity and cost.

TELEVISION

Advantages

1) Operation is so hazardous or inaccessible as to require viewing from more than 100 ft.
2) Simultaneous observation of widely scattered points by one operator or at one control station.
3) Viewing can be brought out around numerous bends and obstructions.

Limitations

1) Limited contrast and linearity.
2) Image has no depth.
3) Servicing and adjustment and the need for standby equipment.

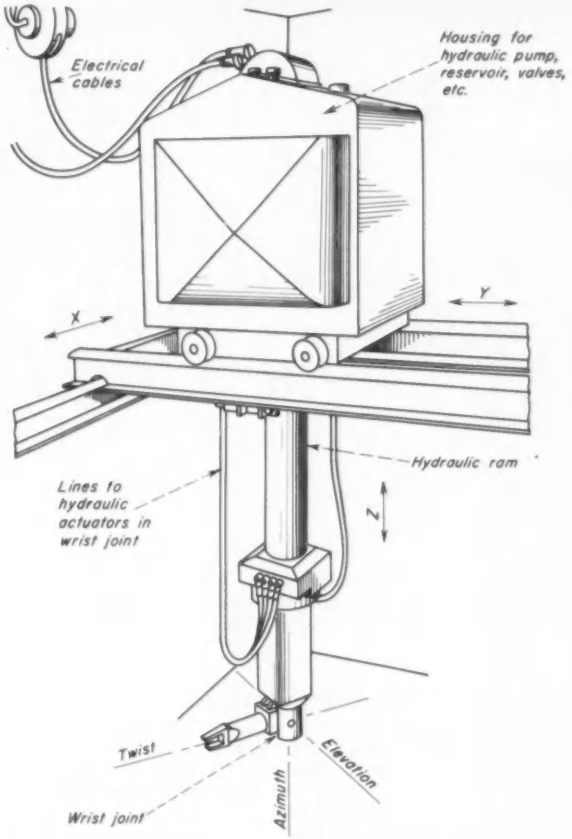


Fig. 47—Electrically controlled hydraulic manipulator by Greer Hydraulics Inc. All motions are hydraulically driven from a single pump. The variable pump output is directed by solenoid valves from a remote control panel. The tongs are remotely interchangeable with a variety of special tools for various operations.

Where the nature of the radioactive material and equipment allows, the entire process may be submerged to a sufficient depth in water. The method is limited because commercial machinery and equipment is usually not suitable for underwater operation, however, some experimental work is being done. There is one machine tool that was custom built for underwater service. Cloudiness or contamination can be controlled by replacing the water periodically or by using a recirculating filter to clean the water.

A shielding window is an opening in a shield that is filled with a transparent material having the same protecting properties as the surrounding shield. Water, concentrated aqeous solutions, other dense liquids and glasses of various compositions have all been used.

Combinations of transparent materials may be used to achieve a window with properties not possible with any single material. The window of Fig. 48 consists basically of zinc bromide solution for its optical quality and economy, supplemented by nonbrown glass for radiation stability, and dense lead glass for reduced thickness of window.

Periscopes should be considered whenever a process, test, or examination must be observed or controlled in the presence of heat, water or harmful radiation. Although confining the instrument does afford maximum protection to personnel and can be arranged to give a field of vision, depth perception, and magnification of objects.

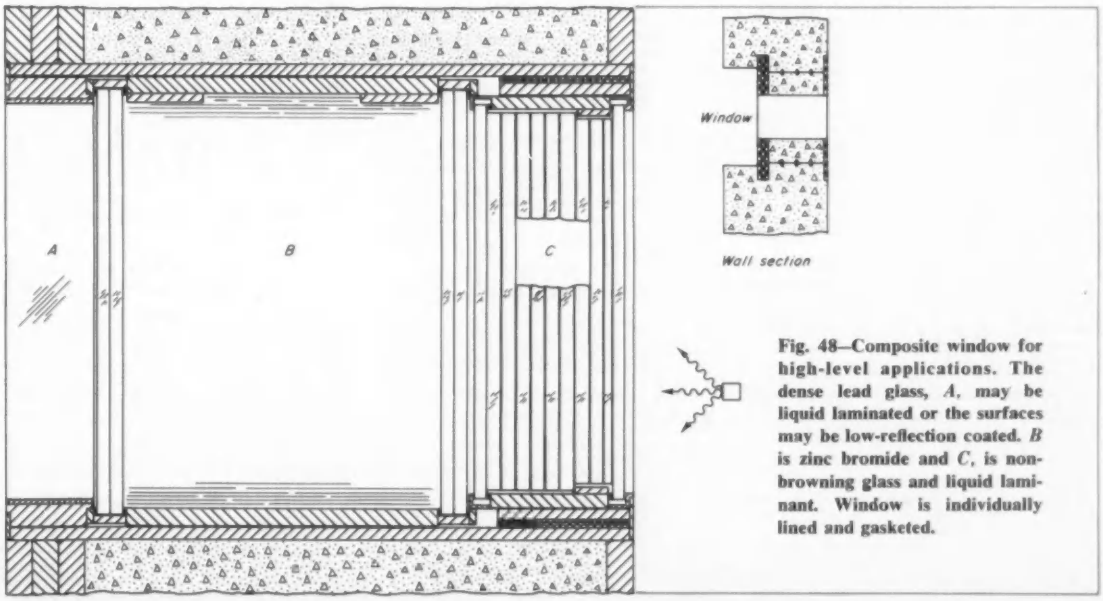


Fig. 48—Composite window for high-level applications. The dense lead glass, *A*, may be liquid laminated or the surfaces may be low-reflection coated. *B* is zinc bromide and *C*, is nonbrowning glass and liquid laminant. Window is individually lined and gasketed.

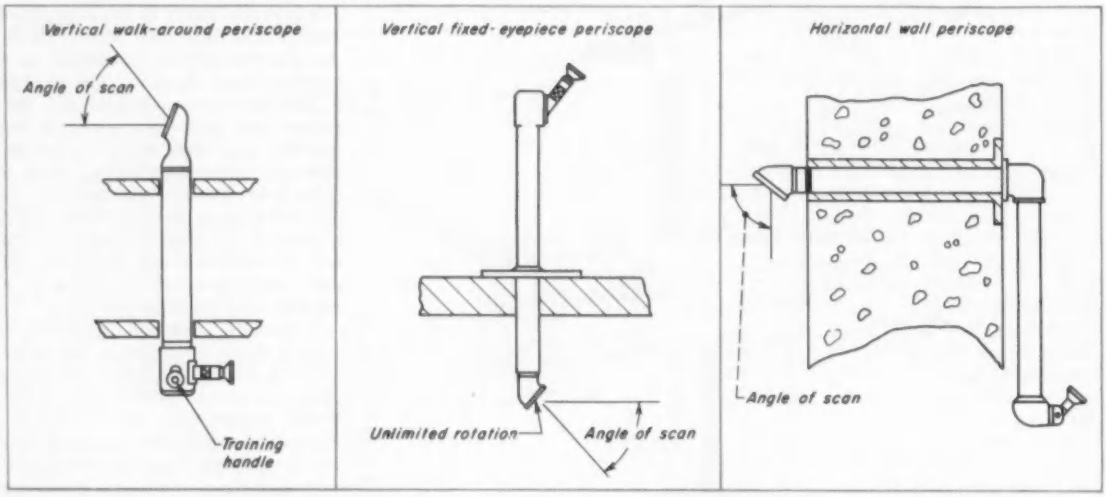


Fig. 49—Typical sketches by Kollmorgen Optical Corp., showing periscopes commonly used. (A) Vertical walk-around. (B) Vertical fixed-eyepiece. (C) Horizontal wall periscope. Special materials are used and shielding provided to reduce danger to personnel and avoid corrosion or irradiation of periscope parts when necessary or dictated by the reactor or test cell installation.

Standard optical glasses are not resistant to darkening by gamma and other high energy radiations. This shortcoming can be minimized by placing shielding around the optical glass parts which are closest to the radiation source. Two other alternatives are available: 1) cerium-stabilized radiation resistant optical glasses are known; and 2) achromatic lenses that withstand intense radiation with minor effect can be made from styrene and acrylic resins.

In Fig. 49 are shown three types of periscopes that may be used for nuclear observations. Other types include: borescopes for inspection of process tubes; microscope-periscope combinations; and binocular-type periscopes.

Television is useful for remote and hazardous viewing. However, the image has no depth and limited contrast ratio and linearity are encountered. Also, intense lighting is required.

Article References

"Reactor Handbook: Engineering," compiled from unclassified data released by the United States Atomic Energy Commission and published by the *McGraw-Hill Book Company, Inc.*

Purpose of the book is to provide a condensed source of reliable data and reference information concerning the reactor field. Volume covers engineering design of reactor, components and auxiliary equipment for the following systems: Light-and heavy-water-cooled; liquid-metal-cooled; gas-cooled; aqueous fuel; liquid-metal fuel; and fused-salt.

Information is basic to the field. Refinements to the systems and equipment have been made, however, since the cut-off date schedule of early 1953, but this and other volumes of the series present a majority of the basic information available.

Nuclear Engineering and Science Congress sponsored by Engineers Joint Council, Dec. 12-16, 1955, at Cleveland, Ohio.

Contributed papers by members of 27 societies up-dated the available unclassified information in the reactor fields. Major fields covered included: safety and site selection; reactor technology and design; heat transfer and fluid flow; radiation damage to structural materials; metallurgy and alloys; radioisotopes and tracer techniques; safety shielding and remote control; liquid metals; instrumentation and control; legal and insurance problems; economics; exploration and production; and other related subjects. The following papers are of particular interest.

"Effect of Nuclear Radiation on Structural Materials" by J. C. Wilson and D. S. Billington, Oak Ridge National Laboratory. Contributed by the AIME.

Effects of radiation are reviewed generally and the mechanical properties of carbon and austenitic stainless steels are discussed in detail. Some instances are shown where certain metals either fail to meet the ASME Boiler Code materials specifications after irradiation or undergo property changes that could be significant in service but would not be detected under existing testing specifications.

"Effects of Nuclear Reactor Radiations on Structural Materials" by Ira F. Zartman, United States Atomic Energy Commission. Contributed by the ASCE.

The different types of nuclear radiations to which materials used in the construction of reactors are exposed is discussed. Conditions imposed by functional requirements are considered. Semi-conductors and plastic materials are also discussed.

"High-Pressure Diaphragm Pumps for Reactors" by J. S. Culver and C. B. Graham, Oak Ridge National Laboratory. Contributed by the American Nuclear Society.

Development of a hermetically sealed diaphragm pump for radioactive solutions is described. The pump consisting of a welded stainless steel diaphragm head with stellite check valves, an isolation device to prevent leakage, and an oil pulsing, actuating unit has a capacity of 1 to 10 gpm against 2,000 psi heads.

"Design and Operation of Freeze Seal Valve and Pumps" by R. Cygan and A. M. Stelle, North American Aviation, Inc. Contributed by the AICE.

Frozen seals have been developed for sealing stationary and rotating shaft penetrations. Units allow the adapting of commercial equipment to liquid metal systems. Several designs for sealing sodium to temperatures up to 1200 F have been tested. Under different operating conditions cooling loads, torque and pressure differentials across the seals were measured.

"Design and Development of Components for the SRE" by William E. Parkins, North American Aviation, Inc. Contributed by the ASME.

Engineering of the Sodium Reactor Experiment has been confronted with a number of new engineering problems. In many instances, experiments were conducted to obtain information on materials behavior or to test components. Results of the design and development work are described for fuel elements, moderator and reflector, control elements, safety elements, tanks and shielding.

"Hydraulic Nuclear Reactor Controls" by Michael Silverberg, Engineer Research and Development Laboratories, Fort Belvoir, Va. Contributed by the ASME.

Describes the applications where hydraulic nuclear reactor controls can be used to advantage. Several types of systems are discussed with emphasis on the desirability of feedback. A general treatment of basic design criteria is given with a suggested system both functionally and from the point of component selection.

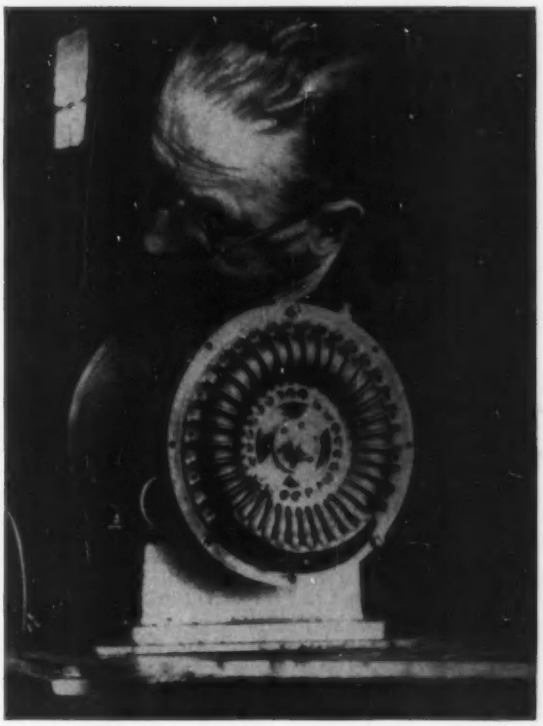
"Problems of Production Reactor Instrumentation" by Thomas R. Vick Roy, E. I. du Pont de Nemours and Co., Inc. Contributed by the AICE.

Some of the problems met in production reactor instrumentation are discussed. Four examples are given: Monitoring flow in reactor cooling channels; monitoring temperature; measuring the relative motion of parts caused by thermal expansion and the control of liquid level in a tank.

"Measurement of Neutron Flux in Critical Assemblies" by J. L. Crandall, E. I. du Pont de Nemours and Co., Inc. Contributed by the AICE.

Methods of measuring thermal neutron flux distributions in experimental reactors are considered. Measuring techniques may be divided into instrumental and activation methods. An instrumental technique may use travelling monitors. An activation technique is the use of a wire moving in the moderator.

TECHNICAL NEWS



INVENTOR BRADSHAW with his new Omega engine. This 1000 cc model develops 55 bhp and weighs 50 pounds. Fuel consumption is reduced by 35 per cent. Design does not set any limitation on the size of engine, and Bradshaw is considering running the larger engines as diesel units with diesel fuel pump attached to rotating cylinder. But there are still many questions as an . . .

. . . Automotive Engine Changes Shape

A rather unique addition to the internal combustion engine field is the Granville Bradshaw Omega engine, which in its simplest form has only 9 moving parts, is at least 50 per cent lighter and 30 per cent cheaper than orthodox types, and develops 25 per cent more bhp from the elimination of friction losses alone. It takes less than half the space of any current engine of comparable power, and will run 200,000 miles without overhall.

According to British designer Bradshaw, the feature of the new engine from which most of the claims originate, is the elimination of the inertia loading and the associated torsional oscillations of the crankshaft. There is a reduction in loads and stresses of about 80 per cent because the inertia loads are now carried almost in full by the explosion pressures at the beginning and compression pressures at the end of every stroke.

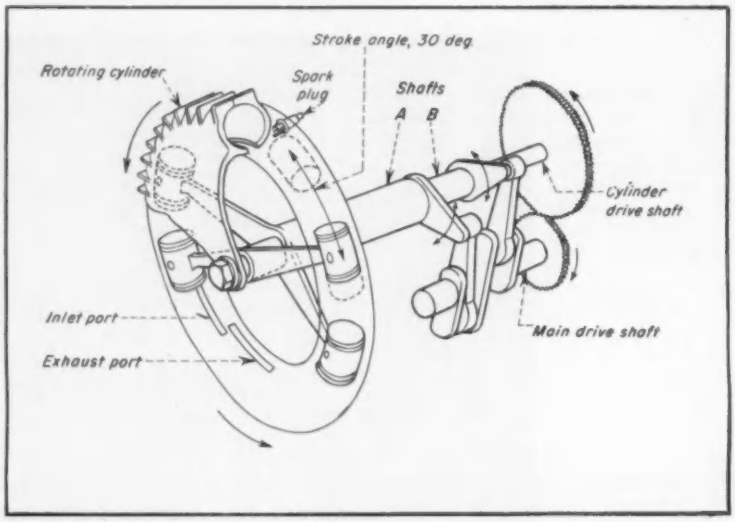
The schematic view (next page) shows how the engine operates. Instead of the gases being compressed and expanded between a piston and a cylinder head, they are compressed between two pistons. Four double-ended pistons oscillate in the one circular cylinder, shaped like a torus. (It is cast in two pieces and bolted together at the periphery.) These pistons are carried on arms which are integral with two central disks (not shown), and splined to the two hollow shafts A and B, with shaft B working inside shaft A. These shafts extend through to the crankcase at right, where they carry one crank arm and one connecting rod each. These two connecting rods drive the two-throw crankshaft by pushing and pulling on both strokes. The two central oscillating disks, to which the piston arms are attached on the shafts A and B, have a running clearance of 0.002 inch.

Bradshaw's aim was to use cylinder wall ports like those in two-stroke engines. He actually does have a four-stroke engine with two-stroke type ports, thus eliminating the reciprocating poppet valve along with the cam, tappet, push-rod, rocket, and, an important item at high rpms, the valve-spring. This was accomplished by rotating the cylinder (at half crankshaft speed) with the gearing arrangement shown at right in the schematic view. The cylinder drive shaft extends through the two tubular main drive shafts, and is fastened by the nut at left. The cylinder is of die cast aluminum and chrome plated in the bore. The entire cylinder is carried on a large steel sleeve which rotates on two ball bearings.

The engine has four firing points, each 90 deg apart, but only one spark plug is used. It is attached to the rotating cylinder and does not stay in the combustion chamber throughout the firing stroke. It ignites combustion chamber one at top center, and moves on to chambers 2, 3, and 4. In effect, it is running away from the heat of combustion all the time.

The pistons rock back and forth through an angle of about 30 deg, which is their stroke. The appearance is like the movement of the escape mechanism of a watch, or a pair of scissors being opened and closed. Because no connecting rods are used, there is no piston friction from side

TECHNICAL NEWS



SCHEMATIC VIEW OF OMEGA ENGINE simplifies explanation of its operation. Cylinder drive shaft is geared down to run at one-half main drive shaft speed. Angle of piston travel is small—about 30 deg—and almost all inertia loads are absorbed in full by the explosion pressures at the beginning and compression pressures at the end of every stroke. Design also eliminates friction caused by connecting rod side thrust.

thrust, and there is no need for close piston clearances like those in a conventional engine to avoid piston slap.

Bradshaw says that his design poses no limitations on speed, and cites speeds of 10,000-12,000 rpm as easily attainable.

One point mentioned as a possible problem in production was the manufacture of the arc-shaped pistons. Bradshaw says that a U. S. firm assured him that they could turn out the pistons in 55 seconds. Also, he claims that the machining time would be less than that required for four separate bores of a conventtional engine. Plating presents no problem.

Air is used in place of water as a coolant. The radial fins on the rotating cylinder running in a stationary casing provide adequate cooling. The distance around the cylinder is about 22 in., and three-quarters of the time the pistons are running over cool parts.

Bradshaw, who is credited with designing the first British aircraft radial engine, says that a number of British automobile companies are looking at the new engine with interest. He added that a Canadian company is building a prototype for use in a chain saw. It will develop 10 hp at a weight of 8 pounds.

First Atomic Electric Power in 1957

The nation's first privately financed atomic electric power will be generated in 1957 from a plant the General Electric Co. and the Pacific Gas & Electric Co. will operate at Livermore and Pleasanton, Cal., about 40 miles southeast of San Francisco. Steam for generating the power will be supplied by an experimental reactor facility, which is part of an atomic laboratory General Electric will be building for development for investigation into the peace-time field of atomic energy. GE owns a 1658 acre site near Pleasonton.

The experimental reactor will feed steam from the nuclear reactor to a turbine generator which will produce up to 5000 kw of electric power. The scheduled operating date is the earliest yet announced for a privately financed atomic power plant, and is the first generation of power from a boiling water reactor designed for dual-cycle operation. This reactor is a pilot plant for the 180,000 kw all-nuclear power plant to be built near Chicago by GE for Commonwealth-Edison Co.

Reports from the Automotive Field . . . .

. . . . Most automobile companies admit that they are in an all-out race to build the fastest cars possible; yet, there is some concern over the effect of the proposed Federal plan to add a cent to the price of a gallon of gasoline in order to finance road construction. With gasoline getting more expensive, the demand for mileage as well as speed in new cars could present design problems.

. . . . The safety angle in cars will be further emphasized in 1957 and 1958 models. One can expect: car roofs of aluminum with a protective cushion on the inside to minimize injuries; arm rests will be recessed into doors and side panels to eliminate all projections; dashboards will be redesigned to accommodate recessed knobs (there is the chance that pushbuttons will be used); inside roof beams will be strengthened.

. . . . The rather ordinary windshield wiper is in for an overhaul—or elimination. One firm has experimented with jets of wet air. It worked well, better than the present wiper design, but at the moment cost is a factor.

. . . . Rear view mirrors inside the car are projections, and consequently regarded as hazardous. One designer feels that all mirrors should be outside, and adjustable from the inside, and that all inside-the-car mirrors should be eliminated. Others favor a parabolic curved mirror mounted either at the top of the windshield or at the bottom, but with car roofs getting lower, it makes this system rather difficult. In the "car-of-the-future" realm is the small television camera mounted in the rear of the car, with the picture projected on a screen on the dashboard.

. . . . There is a gradual trend towards more automatic transmissions in U. S. taxicabs. Air conditioning in cabs is also on the upswing. Plymouth reports that of the 1200 cabs just put into operation in New York City, over 90 per cent have automatic transmissions. Gasoline consumption is said to be about the same as those of manual shifts, and with less driver fatigue. Automobile companies expect to equip about 30 per cent of the cabs

sold to fleet owners with air conditioning.

. . . . A new flexible steering coupling which will improve roadability has been announced by Packard. It is mounted at the base of the steering column, and consists of a composition rubber diaphragm supported by steel disks and splined to separate pieces of the steering column. Road shock transmitted to the steering column will be minimized.

. . . . Just announced by the research staff of the Oldsmobile Div., of General Motors, is a new machine for balancing wheels and tires on a film of air. It uses a so-called air-ball pivot approximately 1½ in. in dia to register automatically both amount and location of unbalance on wheel and tire assemblies. The idea is an outgrowth of an air lubricated bearing developed by GM. The new machine is now part of Oldsmobile's production cycle.

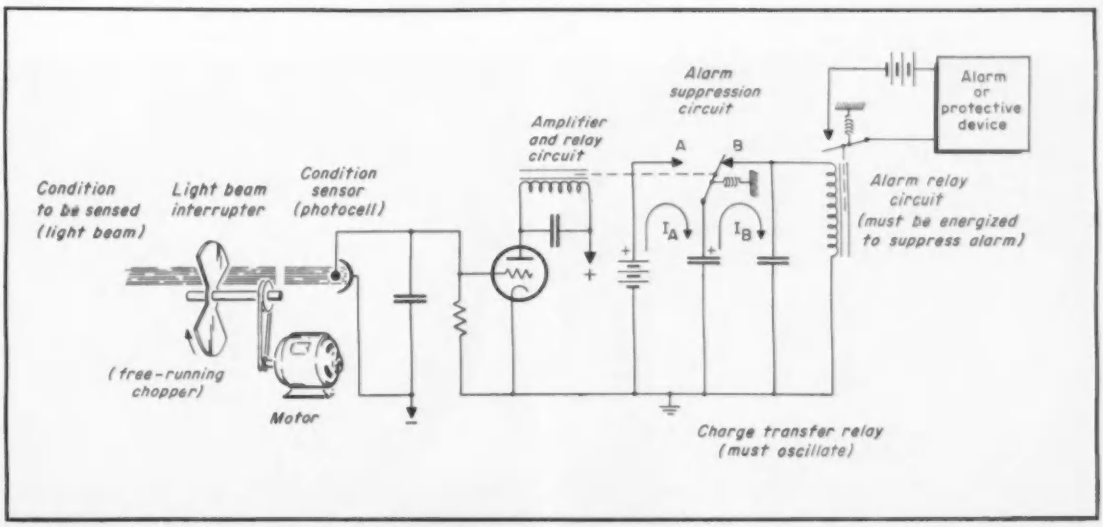
Monitor Checks Self in New Fail-Safe System

"Fail-safe" usually is applied to systems that are safe from the effects of power failure; however, there are many opportunities for unsafe failure because of the unsafe failure conditions in the electronic circuits and physical system. The latest fail-safe system, just announced by the Scully Signal Co., Melrose, Mass., removes the possibility of unsafe failure from any circuit or physical system. In effect, this new technique for monitoring the output of any operating system also checks the monitoring system itself. The system can be used with almost all types of electronic, electrical, and mechanical systems.

The equipment protective devices and system monitors continually check themselves by periodically simulating the unsafe condition they are designed to detect. If the monitor responds to the simulated danger, it will respond to the real unsafe condition when it occurs. Failure of either the operating system or the monitoring system stops the required oscillation and sounds the alarm. The alarm used is normally "on," and is held "off" only when an alarm suppression circuit receives the required oscillating safe-unsafe signal.

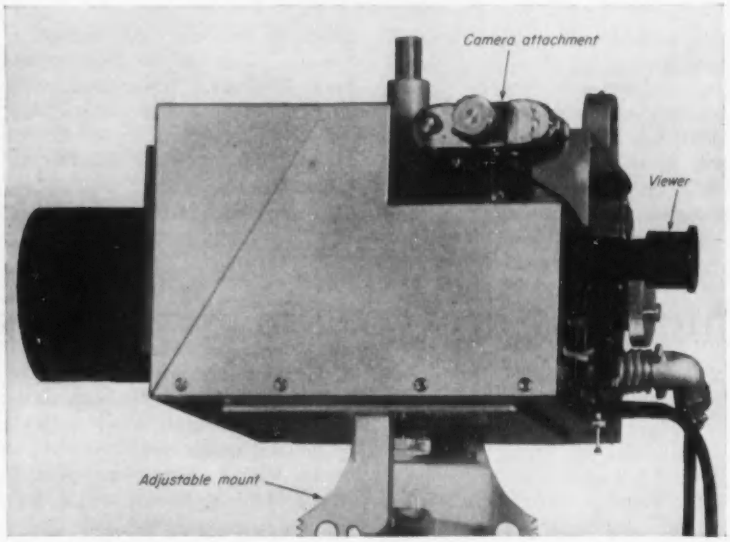
Some examples of this technique which will illustrate the method are: a photocell circuit designed to detect the absence of light is tested periodically by interrupting the light beam (above); a temperature monitoring system is tested by pulsing a heat source in the vicinity of the temperature detector; the operation of a float-type, liquid-level monitor can be proved by sinking the float every few seconds with a solenoid-actuated plunger.

The safe-unsafe oscillation of this system may be caused by a free-running perturbation device at the monitor input, or by the use of feedback to produce a relaxation oscillation within the monitor itself. The frequency of oscillation is determined by the speed with which an alarm must be given following failure of the condition being checked. The safe-unsafe oscillation period must be slightly shorter than the maximum allowable alarm lag, which determines the discharge time-constant of the capacitor in the alarm relay circuit. Oscillation may be from hours to micro-seconds.



A FAIL-SAFE LIGHT MONITORING SYSTEM without feedback, with external modulation of the condition to be sensed. The failure of the light beam is simulated by a motor-driven chopper. This prevents the beam from reaching the condition sensor or photocell, and produces a checking signal modification of the beam. These photocell pulses appear at the grid of an amplifier stage, and periodically energize a relay in the plate circuit. This relay actuates the relay armature in the alarm suppression circuit, and the armature contact alternates successively between positions A and B. If the relay contact stops at either A or B, one or both of the capacitors will discharge and allow the alarm relay to close.

Photographing Heat



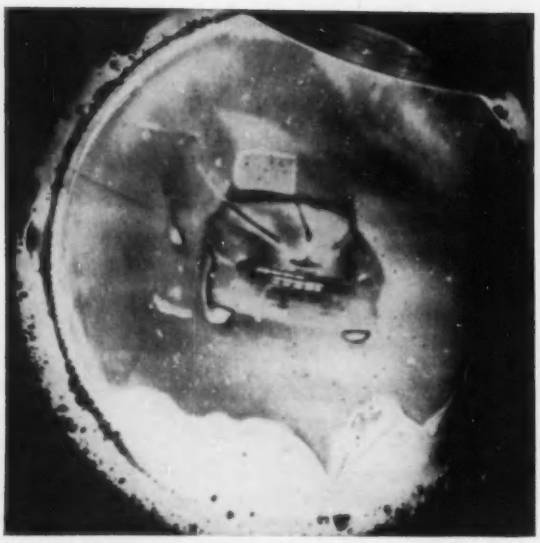
THE EVAPOROGRAPH WITH A CAMERA ATTACHMENT ready to work. The unit is mounted on a tripod with a small vacuum pump on a rack attached to the three legs at the bottom. The time required for an image to be clearly outlined on the oil film is related to the temperature of the background, i.e., a person will be clearly outlined in 6 sec with a difference of 6 C in background temperature.

Spotting a man 200 yd away, or a house a mile away—in total darkness—is just one of the accomplishments of EVA the Evaporograph, a device developed for the Signal Corps by Baird Associates, 33 University Rd., Cambridge 38, Mass., an affiliate of the American Research and Development Corp. The device is a unique research tool for radiation measurement, and using only the infrared radiation from the field of view, the evaporograph produces a direct thermal picture.

In operation the device is similar to a camera. Heart of the device is a thin membrane, 4 micro-in. thick, which is set in an evacuated cell between an optical system and a viewer. The cell is designed so that oil can be condensed uniformly on one side of the membrane. The optical system picks up the infrared radiation from the field of view, and forms an image on the membrane.

A coating on the membrane absorbs the radiation and changes the membrane temperature from point to point, according to the amount of radiation received. The change in temperature alters the oil film thickness on the other side of the membrane. This alteration depends on the local temperature, and when seen in reflected white light from the viewer, these differences in oil film appear as different colors, like oil films on water.

The normal membrane is yellow (the base color) when seen through the viewer, but as oil condenses on the membrane, it builds up in thickness, and the color changes to red, then blue, and back to yellow. The density



HOT TIRES AND RADIATOR stand out in evaporograph picture of a parked automobile at night. Price of the complete evaporograph is $9500. It is also available on a rental basis.

AN EVAPOROGRAPH PICTURE of a girl holding a glass of ice water. Taken in a darkened room at a distance of 30 ft, the cold spots of the objects appear as brighter spots on the image.

of a series of membrane photographs taken during this cycle also varies, cycling in the same manner. Therefore, the radiation from the field of view can be measured visually and photographically, by comparing the rate of thickness change in terms of color or density to the rate of radiation from a body of known temperature and emissivity. These results can be converted to temperatures. The evaporograph can see radiation differences corresponding to temperature up to several thousand degrees F.

Besides seeing in the dark, EVA is used to check the temperature of electronic components or the surface of a process vessel in service for a possible correlation with life expectancy. Also, it can look into wind tunnels to check the surface temperature of objects under a supersonic speed test. Because a warm object will emit more infrared rays than a cold one, the device can aid the construction industry by taking a picture of a house in the winter to locate the points where heat is leaking out. Like the test of electronic components above, the evaporograph can be used to check the hot spots on an engine. On this test it is accurate to ±4 deg. at 1800 F.

New Standard Aluminum Thicknesses Adopted

The Aluminum Association, at the request of the National Aircraft Standards Committee, has just adopted a new schedule of thicknesses for alloy aluminum sheets. Effective the first of this year, it is in line with the American Standard Preferred Thicknesses for Uncoated Thin Flat Metals. The schedule follows the 40-series of preferred numbers as recommended in the standard.

The American Standard was developed at the request of the Society of Automotive Engineers by a sectional committee sponsored by the American Society of Automotive Engineers to provide a standard series of thicknesses in place of the various gage systems. Many of these systems are still in use.

All of the aluminum producers have agreed to adopt the new sheet standards for the thicknesses listed at right in 2024, Alclad 2024, and Alclad 7075 alloys in their present mill standard sizes:

Old Thickness, in.	New Thickness, in.
0.188	0.190
0.156	0.160
0.125	0.125
0.102	0.100
0.091	0.090
0.081	0.080
0.072	0.071
0.064	0.063
0.051	0.050
0.040	0.040
0.032	0.032
0.025	0.025
0.020	0.020
0.016	0.016

So that the producers will have time to work these changes into their procedures and allow the personnel to familiarize themselves with them, the changes will be effective with all the orders acknowledged for the January 1956 and all of the following schedules.

The changeover period of 6 mo on mill shipments and 12 mo on warehouse shipments has been agreed to by air frame manufacturers for accepting existing thicknesses as direct substitutes for the new thickness standards, according to the announcement by the Aluminum Association.

High Temperature Hydraulic Systems

LATEST DEVELOPMENTS of high temperature hydraulic systems, and a comparison of air bleed vs mechanical power extraction were the main topics at the Turbojet Engine Hydraulics Symposium sponsored recently by Vickers, Inc., in Detroit, Michigan. About 75 guests representing 13 foreign and domestic jet engine builders, 10 research and development organizations, 6 airframe manufacturers, 4 fluid manufacturers, 3 airline companies, as well as Vickers' hydraulic engineers took part in the symposium. In the first day's session, three papers dealing with power extraction from jet engines, and two papers on the development of high temperature hydraulic systems were presented. On the second, four more papers on high temperature fluids were presented. As is customary with meetings of this type, all sessions were thrown open to discussion after the papers were read.

In a paper, on "The Effect of Power Extraction on Two Spool Turbojet Engines," E. M. Ramberg and A. E. Gunsolus, of Parameters, Inc., Garden City, N. Y., it was brought out that the air bleed method of power take-off will produce thrust losses off about 2 to 2.5 times the loss found with a mechanical power take-off equipment. This was found to be true for all conditions of ambient temperature, compression ratio, and Mach number. The paper "Servo Pump vs Servo Valve Controls," by L. D. Taylor, of Vickers, Inc., described the physical and operating characteristics of the two controls, and outlined a recommended method design evaluation of the servo pump vs the servo valve for a given installation.

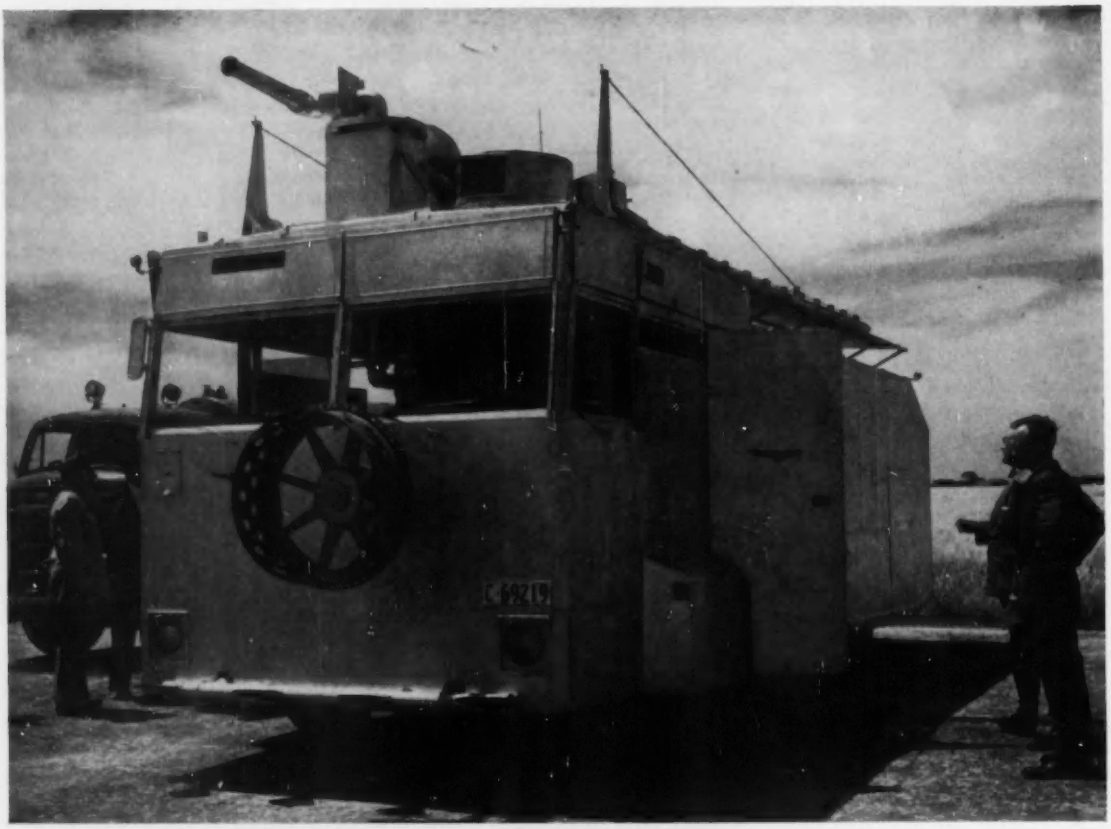
The aim of the government, and aircraft manufacturers in the high temperature field—including fluids and components—is for systems that will operate in the five following temperature classifications: −65 to 160 F; −65 to 275 F; −65 to 400 F; 0 to 550 F; and 0 to 700 F. Goals have been for a life of 10 hours in the 0 to 550 F group, and 200 hours in the −65 to 400 F group.

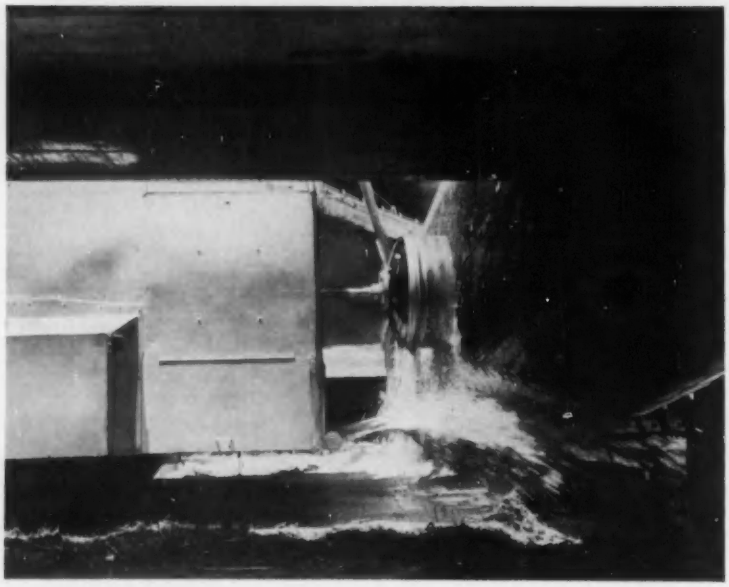
These goals have not been reached. Difficulties have been with seals, and to a lesser extent with metals. But the primary problem is with fluids. According to reports, no fluid will withstand the 550 to 700 F. The 700 F classification has just been established by the military. Lt. H. Schiefer and Mr. R. Rubin, of Wright Air Development Center, announced that tests at WADC have been discontinued because of repeated seal failures.

Mr. W. H. Ragborg, of Dow Corning Corp., Midland, Mich., announced that silicones are promising base materials for high temperature aircraft hydraulic fluids. He added, however, that a possible weakness with silicones is their questionable lubricating qualities with common bearing steels.

H. S. Litzsinger and Dr. R. E. Hatton, of Monsanto Chemical Co., discussed new silicate esters developed at Monsanto will be completely satisfactory for new hydraulic systems.

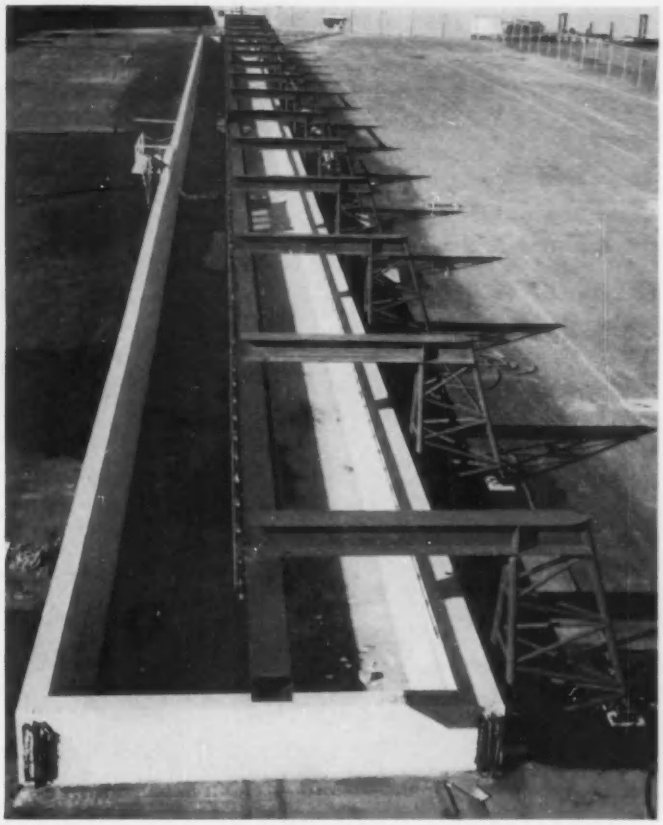
THE NEWS IN PICTURES



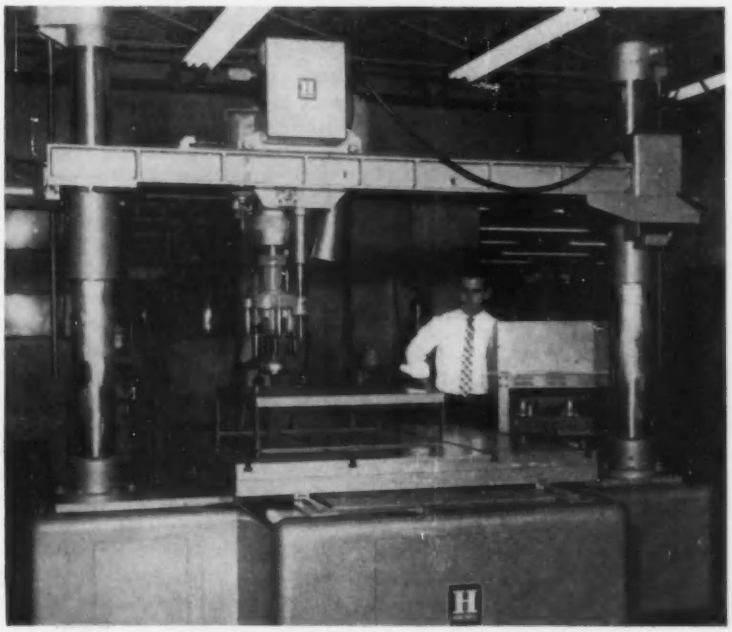


THIS EXPERIMENTAL FIRE FIGHTING and rescue tender (top) built by the Australian Dept. of Civil Aviation is equipped with a remotely controlled "hole" saw, 2 feet, 6 in. in dia, which in three seconds, is capable of cutting an escape hole in the fuselage of a crashed plane, (left). A crew of three in the cabin of the tender are protected by double-skin steel walls insulated with rock wool, and tested to provide protection against outside temperatures up to 1100 F for 30 minutes. In practice, it is expected that such a temperature would be experienced from 3 to 5 min. only. The heat resistant armoured-glass windows are protected by steel shutters as the tender approaches the crash. Foam is sprayed from ground sweep nozzles and a remotely controlled nozzle on the cabin roof.

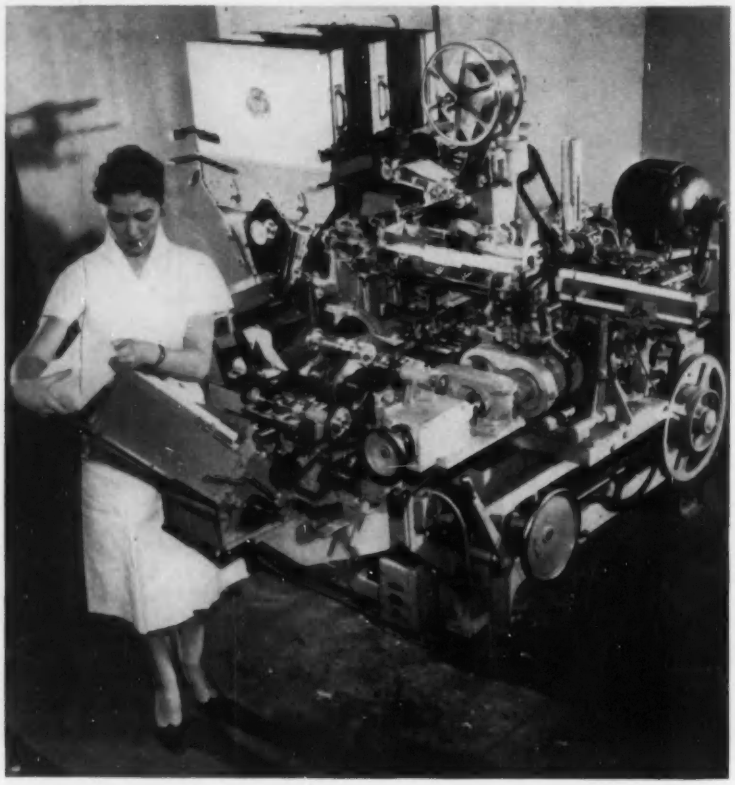
FIBER GLASS SPHERES of 900 cu in. capacity are replacing wire bound steel spheres for aircraft pneumatic appliances. Manufactured by Walter Kidde & Co., Inc., 476 Main St., Belleville 9, New Jersey, the spheres weigh 16 lb, compared to the 25 lb for an equivalent steel vessel. Kidde makes fiber glass spheres in volumes ranging from 50 to 5000 cu in. with operating pressures up to 5000 psi.



NEARING COMPLETION AT Convair Div. of General Dynamics Corp., San Diego 12, Calif., is this 300 ft model seaplane towing basin, the first of its kind on the West Coast. The overhead monorail tows the test models through the water. The basin will be used for research on jet and turboprop seaplanes. Six ft. deep and 12 ft wide, the basin can be used for underwater ballistics studies and the investigation of supersonic aircraft shapes, using the high density of the water in place of air as a test fluid. Plate glass windows on the tank bottom and walls are for photographing the characteristics of the models under test. This is part of a $750,000 hydrodynamics laboratory, which will have two such towing basins and a 100 ft square turning basin, all under roof.



ADAPTING AN electronic control system by Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa., to a special drilling machine built by the Farwell Metal Fabricating Co., 108 Fairfield Ave., St. Paul 1, Minn., permits the operator to "dial" the "X" and "Y" coordinates of a desired hole location, and perform any drilling operation by pressing a button. It is currently being used to drill holes for instruments and dials mounted on master panel boards. The traveling drill head and movable table make any point in a four by four foot square area to be machined. The drill head has a multiple spindle attachment, and can simultaneously drill up to five holes of different size with an accuracy of 0.005 in. Holes from 1/32 in. to 6 in. are possible. The drill head and table are positioned by conventional positional servo-mechanisms. Other controls permit jogging machine motions, spindle speed control, sequence drilling operations, and choice of constant feed or thrust drilling.



First U.S. Designed Hard Box Cigarette Packer

American Machine & Foundry Company's hard-box cigarette packing machine, above, the first of its kind designed in this country. This method of packing cigarettes, a European custom, has suddenly caught on in this country. The new machine, AMF feels, will permit U. S. cigarette manufacturers to meet this foreign competition. The machine can be attached to existing equipment, has an efficiency range of 90 to 95 per cent compared to 80 per cent for other machines, and needs one-third the floor space of competitive machinery.

Depending upon the weight of the paperboard stock used, the finish and printing, the machine can turn out from 100 to 120 hard-box packs per min, compared to 100 per min for other machines, AMF claims. In addition it requires only one operator while other types of packing machinery need three. The design of the new package was made by the Gardner Board and Carton Co., of Middletown, Ohio, and uses only one piece of material, while other machines use two. An aluminum foil container is inside the hard container. AMF says its machine costs less—$10,000 compared to around $29,000 for those of foreign manufacture. In photo above, cigarettes enter the packing process from trays at upper left. Operator is feeding paperboard "flats" into intake hopper. The finished box with 20 cigarettes, inner aluminum foil container, and revenue stamp come off the machine at far right.

Slow-Down on Automation Urged

"We are deluding ourselves if we emphasize automation to the neglect of old-fashioned, sound engineering approaches to production problems," according to George G. Ensign, Dir. of Research, for Elgin National Watch Co. He spoke before a group of industrial executives attending an automation conference held by the Armour Research Foundation of the Illinois Institute of Technology. He was one of 13 speakers at the conference which was set up in an effort to promote a realistic understanding of automation through discussions of the application of automation techniques.

Ensign agreed that automation holds a very bright promise for the future, but added that, "We may so complicate certain processes by over automatising, that we may add to capital investment and maintenance cost to the point where automation actually becomes unprofitable. There are still areas in manufacturing where they are not ready to apply automation, yet improvement in efficiencies can be made in these areas by the application of some sound, old-fashioned ideas of making a better tool or a better arrangement of the job.

Dual-Fuel System Saves Diesel Oil

Diesel locomotives on the Southern Pacific Railroad are now using a "dual-fuel" system which permits part-time use of heavier, less costly fuels. After two years of experiments, the system has been described a success.

Before the experiments, diesels burned fuel that would keep the engines idling efficiently, rather than that which was most efficient under working conditions. The experiments showed that diesels cannot run idle except on comparatively high-grade fuel. However, when they reach working heat, diesels can consume the heavier and less costly fuels, with minor engine adjustments, providing the fuel is preheated to make it thin for spraying into the cylinders.

With the new system, the feed line from a double fuel tank is automatically switched from the high-grade diesel oil needed by an idling locomotive engine to a heavier fuel as the throttle is stepped up, as the engine works harder and hotter. Most modern diesels must idle for at least an hour to warm up for work. Sometimes locomotives are allowed to run as much as four hours to avoid cooling and rewarming problems. Many older diesels are almost never shut off, except when under repair, as cooling and rewarming is often more costly than idle operation.

COMING EVENTS

APRIL 10-12

12th Annual Meeting of the Metal Powder Association, and the 1956 Metal Powder Show, Hotel Cleveland, Cleveland, Ohio. The meeting will cover structural parts, self-lubricating bearings, filters, friction materials, iron powder electronic cores, and others. The latest developments in press, furnaces and other equipment will be shown. Several of the papers are: New Age Hardenable Brass Alloys through Powder Metallurgy; Cerametallic Friction Materials; A Panel Discussion on High Density, Medium Density and Infiltrated Metal Parts; Replacement of Castings by Powder Metallurgy.

APRIL 10-11

American Society of Mechanical Engineers Machine Design Conference, Hotel Bancroft, Worcester, Mass.

APRIL 17-18

1956 Westinghouse Electric Corp., Machine Tool Forum, Statler Hotel, Buffalo, N. Y.

APRIL 18-20

National Industrial Research Conference, sponsored by the Armour Research Foundation as part of their 20th Anniversary, Illinois Institute of Technology, 35 West 33rd St., Chicago 16, Ill. Twelve papers will be presented, with a number of industrialists and research directors taking part in a program designed to guide industry in the administration of more profitable research.

APRIL 19-20

Environmental Equipment Institute, Science Section, Second Annual Meeting, Sheraton Hotel, Chicago, Ill. More information may be obtained by writing to Mr. H. F. Sander, Vapor Heating Corp., 6420 W. Howard St., Chicago, Ill.

MAY 3-9

60th American Foundrymen's Society Castings Congress and Show, Convention Hall, Atlantic City, N. J. A technical-practical program will feature over 60 sessions and shop courses, dealing with the production aspects of cast metals, from raw material stage to delivered products.

MAY 7-11

American Welding Society, Spring Meeting, Hotel Statler, Buffalo, N. Y. The meeting will be held jointly with the 4th Welding Show at the Memorial Auditorium. A total of 65 papers will be read at 21 sessions. The welding committee of the AEC will co-sponsor a session on nuclear reactor components, and the metals engineering division of the ASME will co-sponsor sessions on the welding of dissimilar metals, welding of stainless steel, test of welds, and designing for higher working stresses in pressure vessels.

MAY 9-11

4th Welding Show, sponsored by the American Welding Society, Memorial Auditorium, Buffalo, N. Y. One-hundred companies will exhibit. Twenty-one technical sessions with about 50 speakers are planned. The Metals Engineering Div. of the ASME will join in four sessions, and the welding committee of the Atomic Energy Committee in one session.

MAY 14-17

First Design Engineering Show, Convention Hall, Philadelphia, Pa. The first show of its kind, it will be devoted to, and will have on exhibit, all types of original equipment which go into the manufacture of a finished product. The show is an outgrowth of another show called The Basic Materials Show.

MAY 15-16

Industrial Nuclear Technology Conference, co-sponsored by *Nucleonics* magazine, a McGraw-Hill Publication, and Armour Research Foundation to be held at Armour Foundation, 35 West 33rd St., Chicago 16, Ill. The meeting will be aimed at an industrial audience, and will cover uses of radioactive materials in many industries. Radiation sources and nuclear instrumentation will be included.

MAY 16-18

Society for Experimental Stress Analysis, Spring Meeting, William Penn Hotel, Pittsburgh, Pa.

MAY 17-19

30th Engineering Industries Exposition and Convention of the N. Y. State Society of Professional Engineers, Statler Hotel, New York, N. Y. The Consolidated Edison, one of a number of exhibitors, will show a scale model of the reactor being constructed at Peekskill to supply power generated by atomic energy to New York City. General Omar Bradley and Vincent G. Terenzio, P. E. of the N. Y. City Board of Water Supply, will receive the Society's awards for distinguished service to the engineering profession.

MAY 28-30

Annual Spring Meeting of the National Fluid Power Association, the Greenbrier, White Sulphur Springs, West Virginia. The first day will be devoted primarily to marketing subjects, the second day to public, industrial and government relations, and to education and other subjects of general interest, and the third day to technical matters of which trends and progress toward standardization of terminology, rating factors and limited dimensional standards will predominate. Further information may be obtained from Barrett Rogers, Executive Sec., 1618 Orrington Ave., Evanston, Ill.

JUNE 3-6

40th Annual Meeting, American Gear Manufacturers Association, the Homestead, Hot Springs, Va.

JUNE 4-9

6th International Mechanical Engineering Congress, Paris, France. Further information may be obtained from the Permanent Secretariat of the Congress, 11 Avenue Hoche, Paris VIII, France.

JUNE 6-8

10th Annual Convention of the American Society for Quality Control, Palais du Commerce, Montreal, Canada. More than 80 speakers from the U. S., Europe, and Canada will address the convention. This is the first exhibit held outside the U. S., and present plans include some 40-50 exhibits showing recent developments in gages, calculators and other devices. Plant tours of leading Montreal Industries have been arranged.

The Year Advertising Helped

IN 1954 we had a business recession in the United States. Sales fell about 4% during the year. If management had followed the historic pattern of business ups and downs, advertising volume would have fallen much further.

But in 1954 the volume of advertising did not fall. It increased over 5%. Every effort was made to stimulate sales when sales were needed to sustain prosperity.

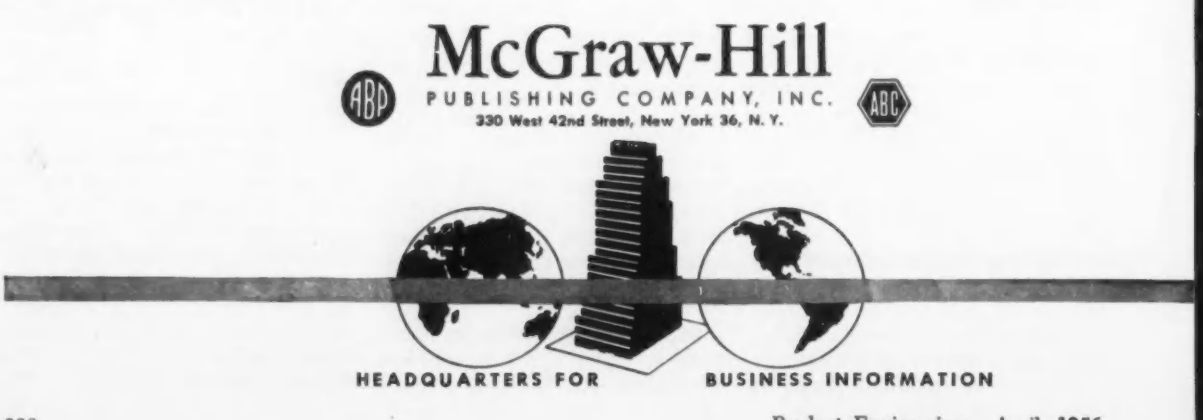
This was something entirely new under the sun. It had a powerful influence in making the recession of 1953-54 one of the mildest on record. It helped greatly to speed business on to the record-breaking levels it has attained today.

There are several reasons why America's business management attacked this decline in sales with more advertising. One of them grew out of the greatly strengthened position of the American consuming market. Consumers' income after taxes has been rising an average of over $10 billion a year since 1946, and this rising income is more widely distributed than ever before. Furthermore, consumers have piled up reserves of about $215 billion in cash or its equivalent. These reserves offer a new and powerful inducement to increased selling and advertising effort even in the face of a possible decline in consumer income.

Taking the Longer View

However, the principal reason why a sales decline was attacked with increased advertising is management's new-found conviction that good advertising is essentially an investment in the development of a market. Successful development requires sustained investment. The inclination of business management to take this longer view, is, of course, motivated by the fact that the American market, with over 3 million consumers being added annually, is growing at a prodigious rate.

Ten years ago only a handful of companies had plans for investment in new producing facilities extending beyond the current year. Today almost all leading companies have investment programs running some years ahead. And keeping pace with these long-range business investment plans has been the development of sales and advertising programs to



Kill a Business Recession

reach tomorrow's greatly expanded markets.

This crucial role of advertising in providing driving power for our economy is gaining greater recognition every day. In his recent book, "People of Plenty," Professor David M. Potter of Yale University remarked: "Advertising is not badly needed in an economy of scarcity, because total demand is usually equal to or in excess of total supply, and every producer can normally sell as much as he produces. It is when potential supply outstrips demand—that is, when abundance prevails—that advertising begins to fulfill a really essential economic function."

Advertising's Key Role

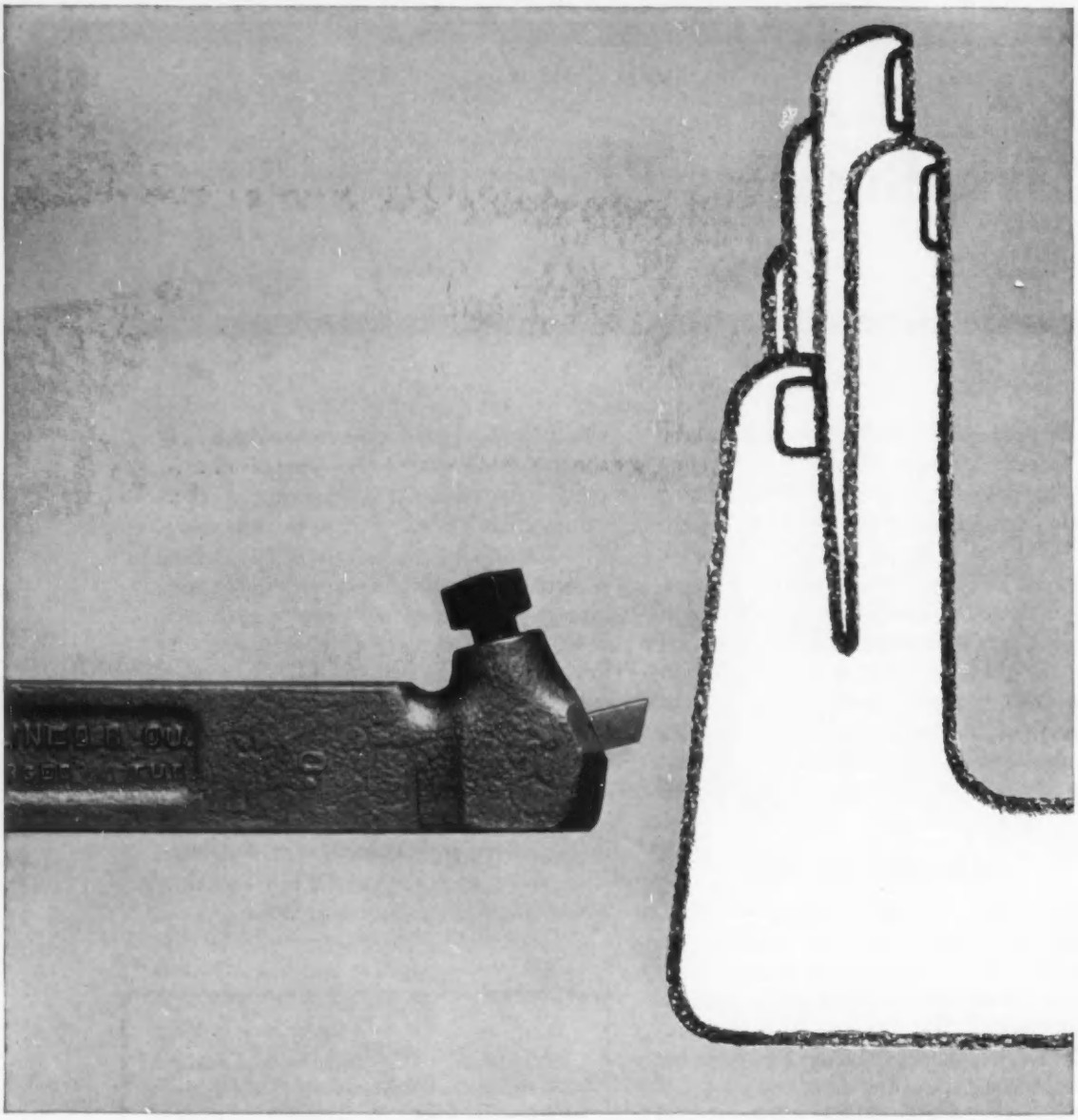
Today abundance so completely prevails in the United States that it has been conservatively estimated that as much as a third of everything offered for sale falls in the realm of "optional consumption." That is, consumers can "take it or leave it" without any immediate personal inconvenience. But if they decide to "leave it," a terrific economic depression will not be far behind. In such circumstances, advertising—in which, in all of its forms, we are now investing about $9.2 billion annually—clearly is of crucial importance to our continued prosperity.

In performing its key role in past years, American advertising never realized its full potential. It successfully promoted sales. But it never was called upon to promote an overall economic stability as a direct outgrowth of increased sales.

By successfully promoting both sales and economic stability, as it did in 1954, advertising surely has added new strength to the American economy. It has also added a great new and constructive dimension to advertising itself. This accomplishment gave great significance to the celebration of the first National Advertising Week in February, 1956.

One of the surest means of expanding your sales volume in today's $150 billion *industrial* market is through dominant advertising in the publications directly serving your major customers and prospects.

McGraw-Hill's business and technical publications can give you quick access to the men who initiate, specify and approve the purchases of industrial products and services. Because all are leaders in their respective fields, you are assured a maximum return on your investment when you specify a McGraw-Hill publication to carry your advertising to your most important markets.



If you need to control machine operations, it'll pay you to use

Adlake mercury relays

Adlake relays require no maintenance whatever...are quiet and chatterless...free from explosion hazard. Dust, dirt, moisture and temperature changes can't affect their operation. Mercury-to-mercury contact gives ideal snap action, with no burning, pitting or sticking. Time delay characteristics are fixed and non-adjustable.

For more information about Adlake Relays, write The Adams & Westlake Company, 1169 N. Michigan, Elkhart, Indiana.

The Adams & Westlake Company

Established 1857 • ELKHART, INDIANA • New York • Chicago

the *original* and largest manufacturers of mercury plunger-type relays

Adlake 99th year of serving the transportation, building and control industries

Pressure Losses In Flexible Metal Tubing

C. M. DANIELS, North American Aviation, Inc.

Friction coefficients and pressure loss data for corrugated flexible hose of annular and helical types at high flow rates (Reynolds Number 2 x 10^6).

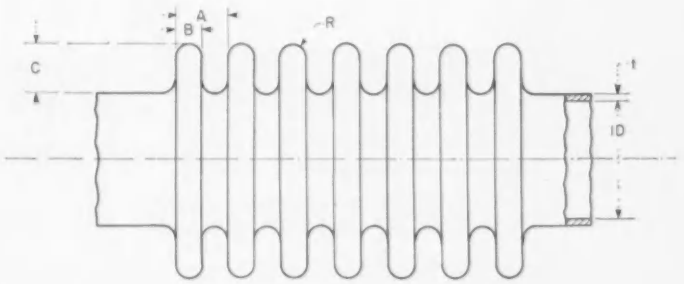
SYMBOLS

ΔP — total pressure drop, psf
f — coefficient of friction
L — length of pipe, ft
D — inside dia of pipe, ft
ρ — density, lb/ft³
v — velocity, ft/sec
g — acceleration due to gravity, 32.2 ft/sec²
ϵ — absolute roughness, or effective height of pipe wall surface irregularities, ft

LARGE FLEXIBLE METAL TUBING such as that illustrated in Fig. 1 can be used to compensate for thermal expansion and misalignment as well as to permit relative motion between two rigid hydraulic lines. It offers a quick and convenient method of connecting two separate hydraulic systems without special fittings. However, because of its construction, the loss through a given size hose may be seven to fifteen times greater than that of a comparable size steel pipe.

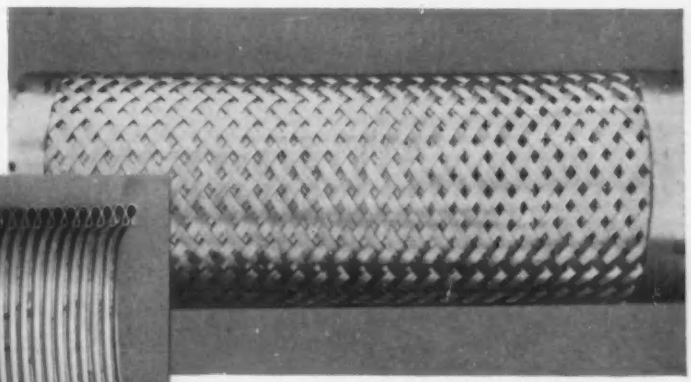
Presure loss versus flow rate data for the test hoses are plotted in Fig.

(continued on page 225)

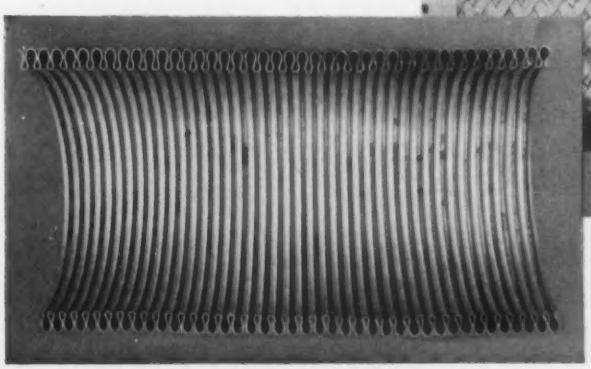


Hose Size and Type	A	B	C	R	t	ID
2 in. Annular	0.213	0.150	0.303	0.063	0.040	2.075
2 in. Helical	0.264	0.207	0.332	0.078	0.075	2.019
3 in. Annular	0.338	0.236	0.424	0.078	0.067	2.962
3 ½ in. Annular	0.185	0.163	0.280	0.046	0.022	3.492

Fig. 1—Geometry of test hoses.



Typical flex hose with braid.



Cutaway of flex hose section.

New COMPO E®

BEARING MATERIAL

SAVES UP TO 40% ON BEARING COSTS • COMBINES THE ADVANTAGES OF BOTH BRONZE & IRON • SUPPLIES "BUILT-IN" LUBRICATION OF 23% BY VOLUME • INSTALLS AS EASILY AS HIGHER-PRICED BRONZE BEARINGS • OPERATES AT SHAFT SPEEDS UP TO 3500 RPM • AN EXCLUSIVE BOUND BROOK MATERIAL BACKED BY 73 YEARS' EXPERIENCE

write today for complete data

BOUND BROOK

BOUND BROOK OIL-LESS BEARING CO., EST. 1883, BOUND BROOK, N. J.

Pioneer in

POWDER METALLURGY BEARINGS + PARTS

Pressure Losses in Flexible Metal Tubing (continued from page 223)

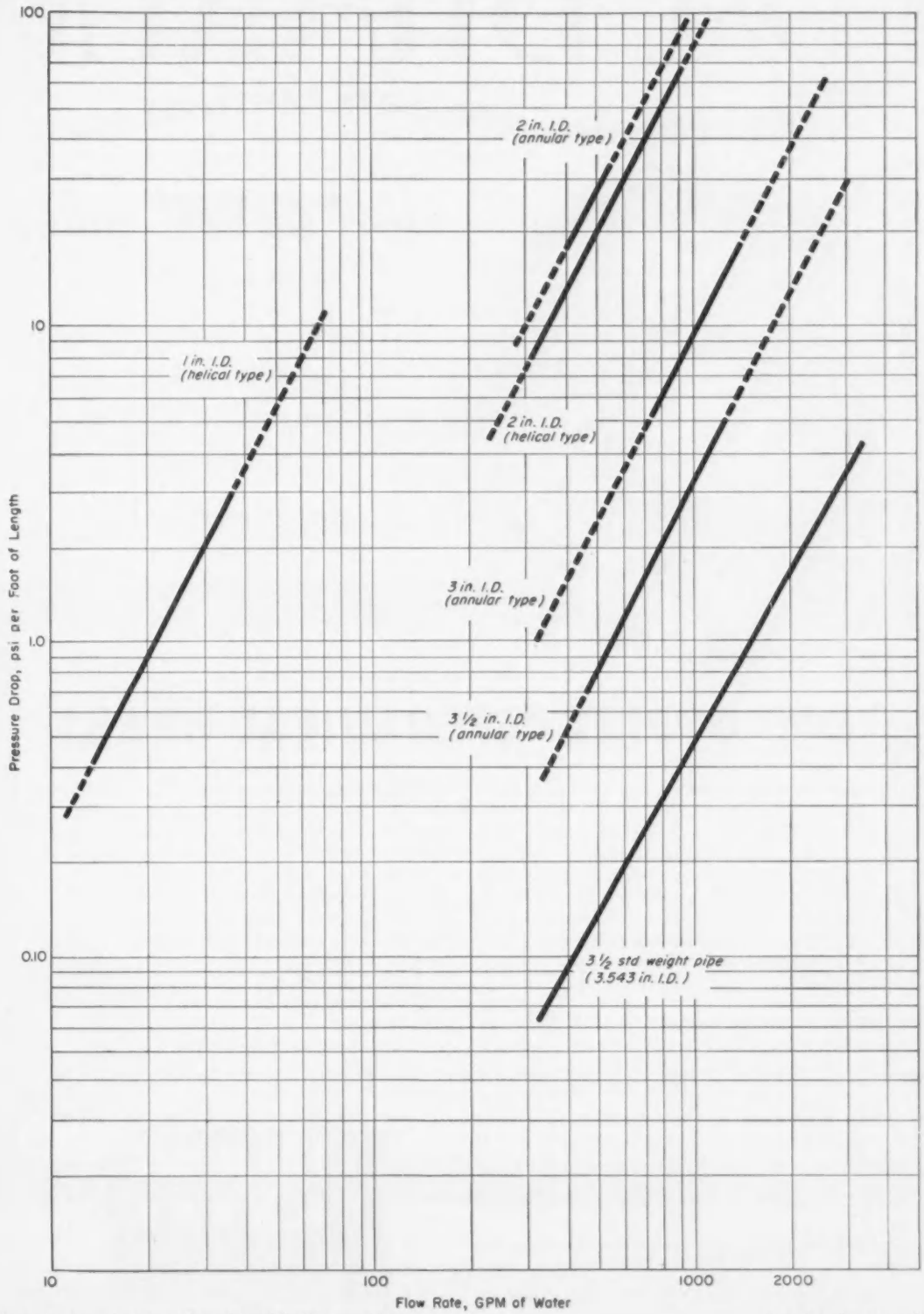


Fig. 2—Pressure loss through unsleeved flexible metal hose.

(continued on page 227)

TDA® BRAKES

if it rotates...we can control it!

new "DM" brake

...farm equipment

...special duty utility trailers

...lightweight highway trailers

...industrial machinery

"DM" DUPLEX MECHANICAL BRAKE

Best on many jobs, this rugged new DM Brake actually outperforms more specialized brakes. It has proved its worth with farm equipment, special duty utility trailers, light duty highway trailers, industrial machinery, and in a wide variety of special applications. In its many fields, the DM Brake has given outstanding service—providing exceptionally high-torque output and maximum performance for its size.

Greater torque output! The DM Brake is a self-energizing, balanced type . . . the two identical shoes do an equal amount of work in either forward or reverse direction.

Simpler Maintenance and Adjustment! The DM Brake is wedge-actuated through an easily accessible operating lever, giving positive braking with immediate response. The DM Brake can be actuated by either an air or hydraulic cylinder, or mechanical means. Complete accessibility permits quick, easy adjustment. Simple design minimizes maintenance and service.

For expert consultation on your brake problems, contact the Timken-Detroit® Brake Division. Specifications of the DM Brake now available.

©1956, R S & A Company

TIMKEN Detroit BRAKES

ROCKWELL SPRING AND AXLE COMPANY

Accepted Standard

For every industrial, agricultural or automotive application where braking is required!

TDA plants at: Detroit, Michigan • Oshkosh, Wisconsin • Utica, New York
Ashtabula, Kenton and Newark, Ohio • New Castle, Pennsylvania

Pressure Losses in Flexible Metal Tubing (continued from page 225)

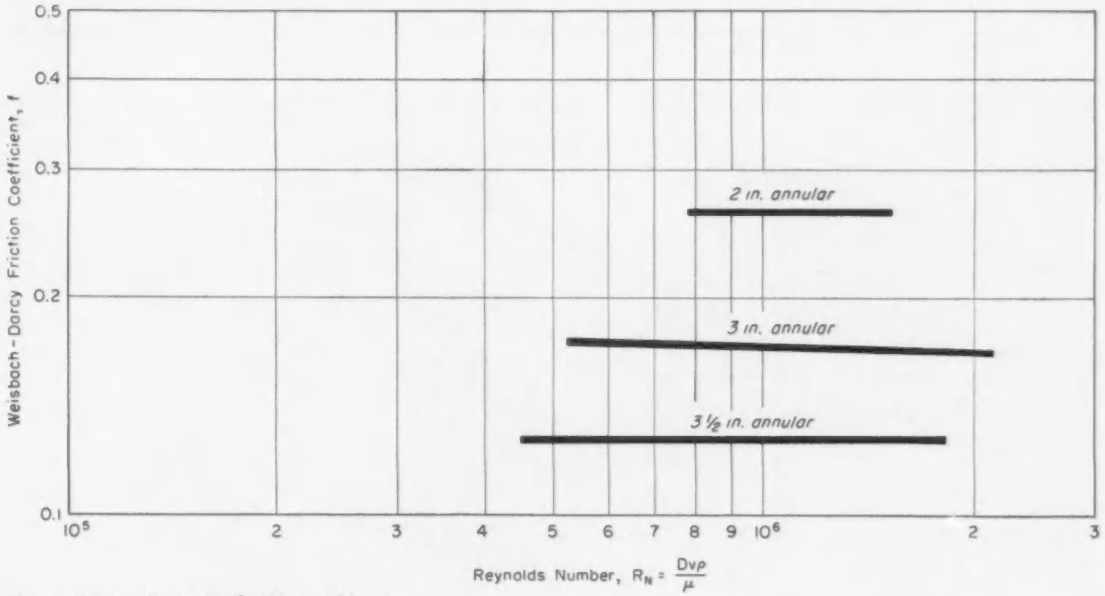


Fig. 3—Friction factors for flexible metal hose.

Hose Size and Type	Roughness Factor $\frac{\epsilon}{D}$	$\frac{\Delta P \text{ Flex Hose}^*}{\Delta P \text{ Schedule 40}}$	Friction* Coefficient
2 in Annular	0.0728	15.95	0 264
2 in Helical	0.0820	11.75	0 193
3 in Annular	0.0715	9.9	0.173
3 ½ in. Annular	0.0400	6.9	0.127

*@ 1000 GPM of water

2. Using the Weisbach-Darcy equation for frictional pressure loss,

$$\Delta P = f \frac{L}{D} \rho \frac{v^2}{2g} \qquad (1)$$

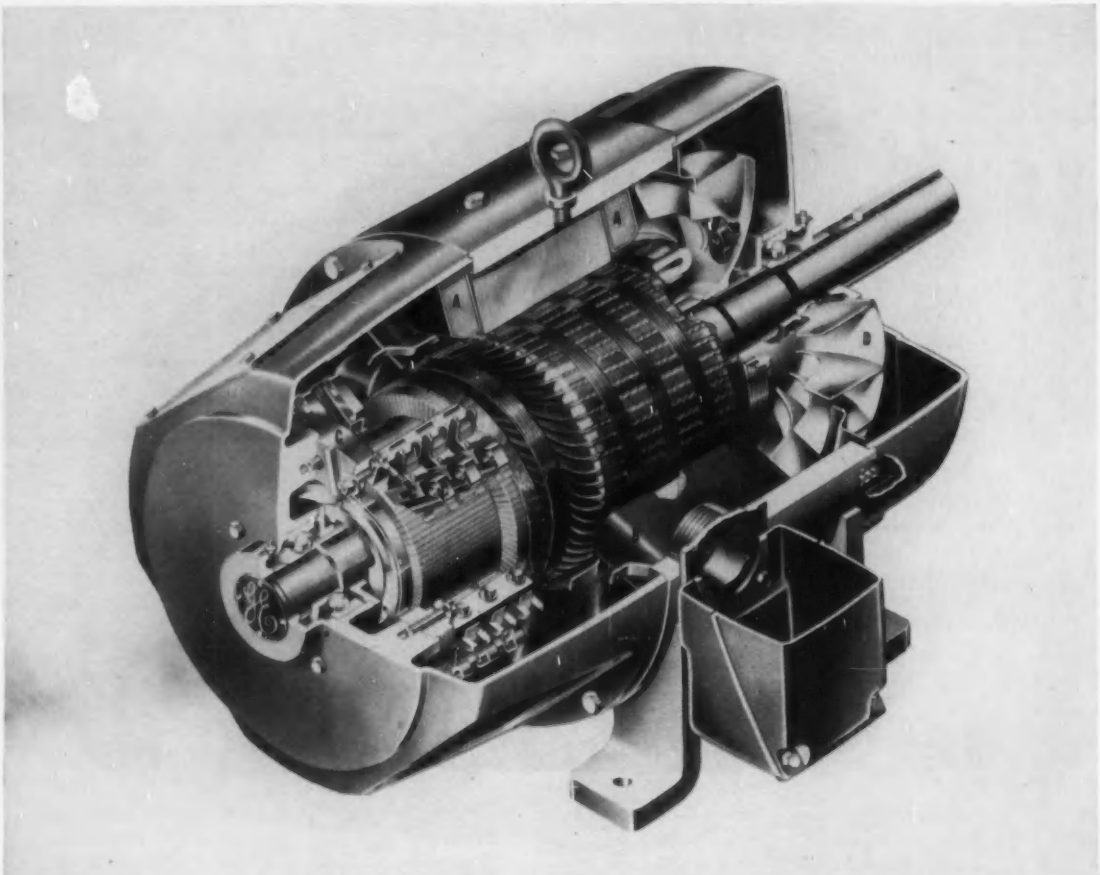
friction coefficients were calculated for the annular type hoses and plotted in Fig. 3. Note that the friction coefficient decreases with increased line size. This is consistent with conventional pipe and tubing behavior.

The high pressure drops encountered in the flexible metal tubing tests can probably be attributed to the high Reynolds Number and the pipe roughness, the convolutions acting much the same as a very rough wall. Normally the term ϵ in the roughness factor ϵ/D is the effective height of protuberances within the nominal tube *ID*; the convolutions do not extend within the tube *ID* and therefore do not rigorously follow the roughness factor criterion. Above table lists roughness factor, friction coefficient, and ratio of flex hose pressure loss for the test hoses.

The effect of the convolutions on the flow pattern is not known accurately but from the comparative data on the 2 in. hoses, it can be seen that the helical type has a lower pressure loss in spite of a higher roughness factor than the annular type. Swirling flow in the helical convolutions may have, in effect, added to the flow area.

It can be seen from Fig. 3 that the friction coefficients are fairly constant. In the ASME Transactions, November, 1944, page 671, L. F. Moody confirmed the fact that at some Reynolds Number for each relative roughness, the friction coefficient ceases to vary with R_n, and becomes a constant. A similar behavior is also found in venturimeters and long-radius nozzles.

As is usually the case with pressure loss test data for tubing, pipe, valves, and fittings, the results of tests on similar items will vary considerably between investigators. This is a result of differences in test set-ups, pressure tap locations, geometry of the test specimens, and instrumentation.



CROSS-SECTIONAL VIEW OF D-C-MOTOR. Exciting and commutating field coils (A, B) are insulated throughout with mica, glass and other inorganic materials. Brush rigging (C) has holder yoke made of polyester glass. Fan (D) is aluminum.

D-c Motors and Generators

Built to the latest NEMA standards for d-c motors and generators, all motor ratings from one to 150 hp and all generator ratings from ¾ to 100 kw are available, for both constant and adjustable speed applications. Speed may be adjusted by either armature voltage control, field strength control, or any combination of both. For constant horsepower applications, higher top speeds can be obtained through field strength adjustment.

The d-c motor can also be applied where extra power at high speeds is needed. Through application of overvoltage, many ratings can operate at proportionately higher speeds and horsepower. When properly applied, the motor can operate at any speed below base speed, including stalled torque. This low speed performance is especially important for process changes, threading and setting up operations, and adjustable speed duty cycles.

Faster speed of response is made possible by a significant reduction in armature inertia (WK^2) and electrical time constant permitting split-second response for quick stops and starts and fast reversals and speed changes.

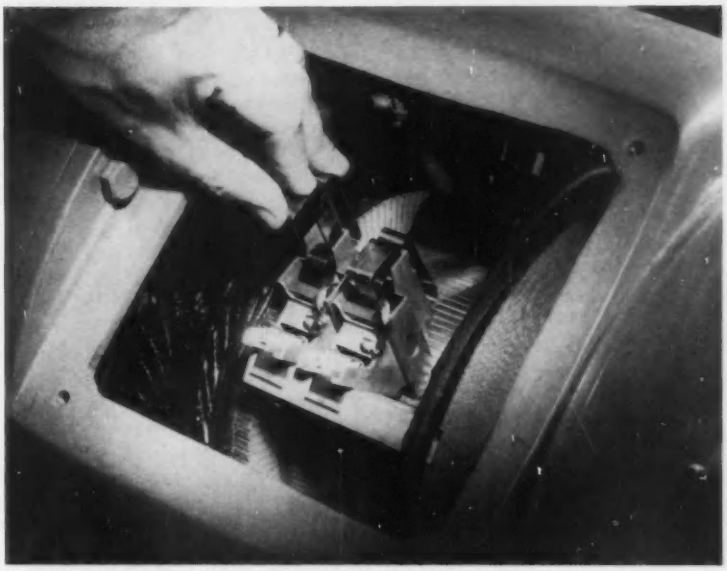
Peak commutation, to take safely the short bursts of power necessary for quick acceleration and deceleration, has been built into this d-c drive. Fewer turns per armature coil are asserted to assure minimum inductive kick when stored energy is released from the coil. A full complement of

commutating poles permits greater overloads without magnetic saturation.

Full Class B insulation, a high volume fan and improved air flow enable the manufacturer to guarantee a 15 per cent service factor in all standard dripproof motors. Users can take advantage of the service factor in three ways: to obtain 15 per cent more than rated power continuously for normal life of the motor, obtain longer motor life at rated power and obtain greater versatility on speed and horsepower duty cycles.

Split, cast iron, waterproof conduit boxes are supplied available in three sizes for each motor frame. The standard d-c motor has a rolled steel frame with cast iron dripproof endshields. An eyebolt is provided on all motors for safer, easier lifting. General Electric Co., Schenectady 5, N. Y.

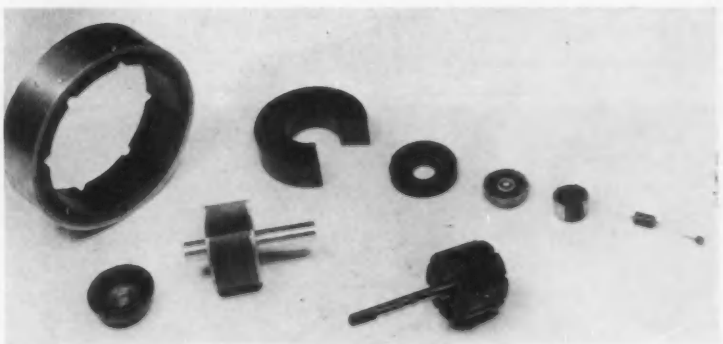
For more information—Circle 1, inside back cover



LARGE HAND HOLE permits easy access to commutator. Spring is disengaged by hand, and then hangs captive to brush holder.

Molded, Plastic-Bound Permanent Magnets

Pressed, plastic-bound permanent magnets are now available to American manufacturers after having been used in Germany for a number of years, according to the manufacturer. The method of manufacture makes it possible to press shafts, temperature compensation pieces and bearings right into the magnets. Magnets of intricate design can be made on a mass production basis which would be impossible or uneconomical with cast or sintered magnets. All machining is said to be eliminated.



Ratio of total magnet energy to useful energy is reported to be better for the new plastic-bound material. The manufacturing process involved (compression molding for thermosetting resins, injection molding for the thermoplastics — especially for tiny parts) is better suited to iron-barium-oxide magnet mixtures than the Alnicos. The new magnets weigh about 20 per cent less than comparable sintered or cast magnets, according to the manufacturer.

Magnets weighing from as little as thousandths of an ounce to 4 oz can be made of this mixture of plastic resin and magnet alloy powder.

Following are some of the characteristics and mechanical properties of the new magnets. Compression strength is 17,000 psi; bending strength, 1700 psi; specific weights: Alnico mixture, 3.1 to 3.6 oz/cu in.; oxide mixture, 2.1 to 2.4 oz/cu. in.; shock resistance, 125 G; maximum temperature, 400 F; average coefficient of expansion, 15.

Peak magnetizing force ranges from

CONTINUED ON PAGE 230

6045 to 12,100 amp turns per in., depending on the type involved. Residual magnetism is 377 to 4300 B., Gauss x 10^6. Energy, 1.15 to 2.62 BH max. Coercive force, 1058 to 1925 amp turns per in. Baermann-Nord Corp., Amherst, Ohio.

For more information—
Circle 2, inside back cover

Ceramic Permanent Magnets

A low-cost, ceramic permanent magnet material is said to combine adequate energy product with high coercive force, low residual induction, virtually 100 per cent electrical resistivity and exceptional resistance to demagnetization. These characteristics and the non-critical nature of the ceramic make magnets of this material usable for all ordinary permanent magnet uses as well as others of a more exacting nature, such as those where the magnets may be exposed to strong demagnetizing fields. The units are reported to retain their energy even when used without "keepers" or under other closed-circuit conditions, and in the presence of strong opposing fields. As an example, these magnets cannot be demonstrated by another magnet of a force up to 2,000 gauss.

The new magnets are practically non-conductors. Electrical resistivity is 6 x 10^{10} ohm/cc, making them suitable for high-frequency and high-voltage circuits. They can be placed in the direct path of electro-magnetic energy to rotate the polarization plane, to focus cathode ray tube beams.

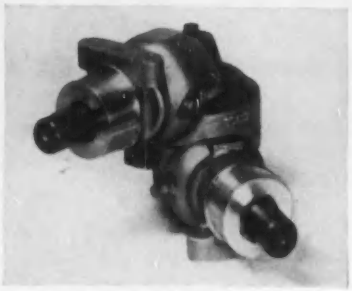
Their magnetism will be unaffected by their surroundings. They themselves will exert little or no proximity effect on nearby circuitry. Another feature that may offer possibilities is that temperature characteristics are linear, including retrace, to 400 C.

Made of non-critical, inexpensive barium and iron oxides, these permanent magnets are classified among the hard magnetic materials. They cost materially less than metallic magnets. Also, they weigh less, 4.85 g/cc.

Although the magnet's energy product (0.915 x 10^6 gauss-cersteds at 600 gauss working point) is less than that of conventional metallic permanent magnets, the important point is that their full energy is available under practically any condition.

Units are available in practically any size or shape. They are machineable by wet grinding and may be machined after magnetizing. Although they can be magnetized in any direction, highest energy product is obtained across thinner sections. Stackpole Carbon Co., St. Marys, Pa.

For more information—
Circle 3, inside back cover



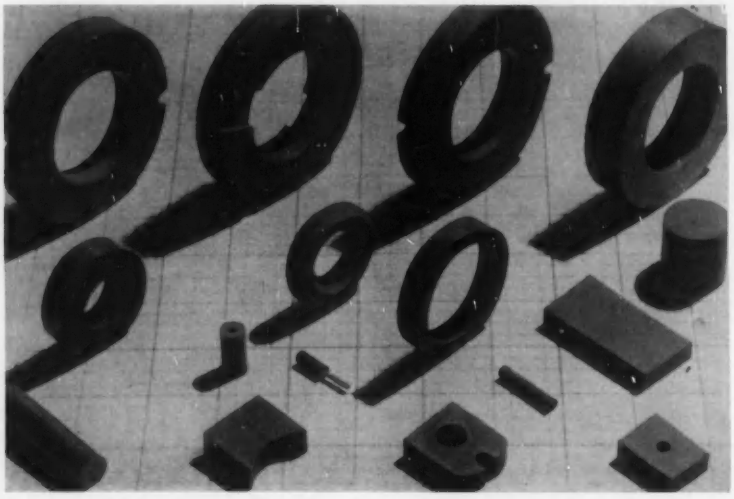
Geared Joint for Angles of 45 to 315 Deg.

This geared joint is actually an adjustable gear box that transmits torque at any angle from 45 to 315 deg. It has needle bearings which are said to have increased efficiency approximately 60 per cent. The primary use for the geared joint at present is for making sharp bends in remote control linkages using flexible shafting or reach rods. These sharp bends are often necessary in order to avoid obstacles.

The worker installing the unit connects up each end to either flexible shafts or reach rods, brackets the joint in place at one end, and then drills a spot for a set screw to keep the two halves of the joint at the proper angle. With the needle bearings, the geared joint can now be used for power applications with speeds up to 500 rpm.

These geared joints are available in three sizes, rated at 500, 2000 and 3500 lb-in., and designed for $\frac{1}{4}$ to $1\frac{3}{8}$ in. shaft sizes. Stow Mfg. Co., 426 State St., Binghamton, N. Y.

For more information—
Circle 4, inside back cover



High Speed Magnetic Switch

This switch is controlled by the proximity of a magnetic field (see magnet on revolving wheel in illustration). When the magnet is moved close to the face of the switch, the switch arm transfers contact, and as the magnet moves away, the switch arm returns. It is possible for the unit to register speeds from zero up to a transient magnetic field of only 8 millisec.

The switch can be used as a sensing

CONTINUED ON PAGE 232

Using

DU PONT ELASTOMERS

NEOPRENE • HYPALON®

in Design

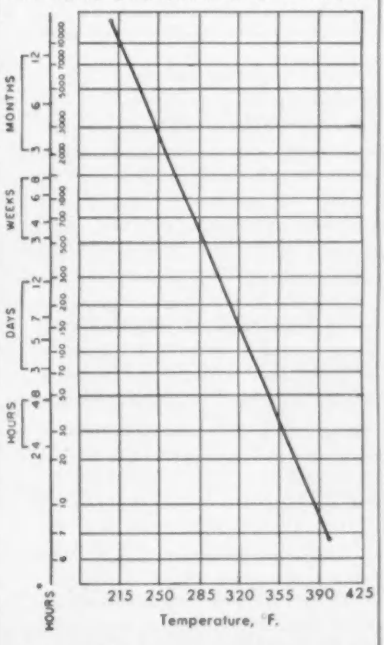
HYPALON® products have exceptional heat resistance

Compared to other kinds of rubber, HYPALON shows unusual resistance to hardening at elevated temperatures (250°-350°F.). This means an extra-long service life for HYPALON belts, hose, gaskets and other products which are used where heat is a problem.

The graph below is indicative of HYPALON's heat-aging characteristics. It shows, for example, that HYPALON compounds will retain 100% elongation after three weeks' *continuous* exposure at 285°F., three months at 250°F. and almost a year at 212°F. Longer service life naturally can be expected where temperatures are intermittent, or where air cannot get at the product—in a gasket, for example.

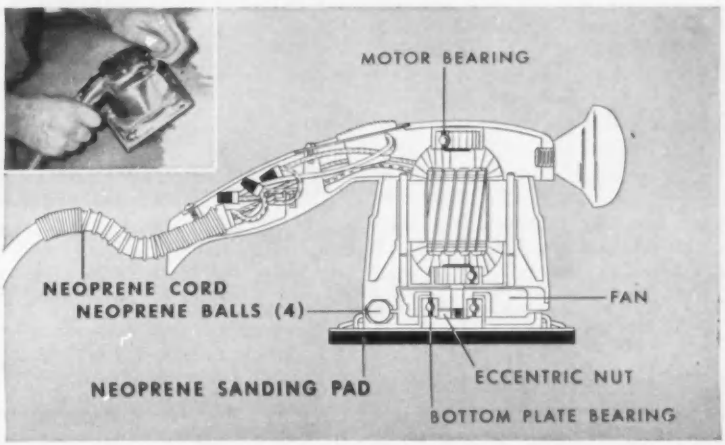
Other advantages of HYPALON include outstanding resistance to weather and oxidizing chemicals, *complete* resistance to ozone and the ability to be compounded in a wide range of light-fast colors.

HEAT AGING CHARACTERISTICS OF HYPALON®



*Exposure time in which elongation dropped to 100%.

Over 200,000 sanders in service—and manufacturer has yet to replace one NEOPRENE part



Low-cost neoprene ball bearings last life of sander... resist abrasion, solvents

Since 1950, a manufacturer of sanders has sold 200,000 units—each with a neoprene sanding disk and a system of neoprene ball bearings. Not one of these neoprene parts has required replacement in that time.

Ingenious use of neoprene

The sander's design is shown above. An eccentric nut attached to the motor shaft imparts a circular motion to the plate that holds the sanding pad. Between this plate and the motor housing are four ½" neoprene balls—one at each corner and each confined in a cavity of 19/32".

These neoprene balls transmit vertical force from the sander to the surface being sanded. They also act as roller bearings as the sander revolves. Finally, thanks to neoprene's resilience, they serve as shock absorbers—minimizing noise and vibration.

Neoprene beats competitors

The manufacturer tested many materials for the balls. Steel balls were noisy and wore out quickly. Natural-rubber balls deteriorated within three weeks when exposed to paint solvents in wet sanding. In the same tests, however, neoprene resisted abrasion and solvents for nearly a year.

Basing his judgment on these tests, the manufacturer chose neoprene not only for the bearing balls but also for the pad to which the abrasive paper is attached. And as a further improvement, neoprene-jacketed cord was also adopted.

DU PONT
REG. U.S. PAT. OFF.

HYPALON *is a registered trademark of E. I. du Pont de Nemours & Co. (Inc.)*

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

Please send further literature and add my name to the mailing list for your free publications, the "Neoprene Notebook" and "Facts about HYPALON®," which show how the Du Pont elastomers are used in designing new products, improving old.

E. I. du Pont de Nemours & Co. (Inc.)
Elastomers Division, Dept. PE-4
Wilmington 98, Delaware

Name _____ **Position** _____

Firm _____

Address _____

City _____ **State** _____

device for actuating electrical and electronic circuits. It is said to provide sharp, clean "make and break" with no bounce at the highest or lowest speeds. Capable of speeds up to 200 cps, the device is reported to have a life of over 30 billion cycles. Contacts are single-pole, double-throw, rated at 5 amp, non-inductive. Post Machinery Co., Beverly, Massachusetts.

For more information—
Circle 5, inside back cover

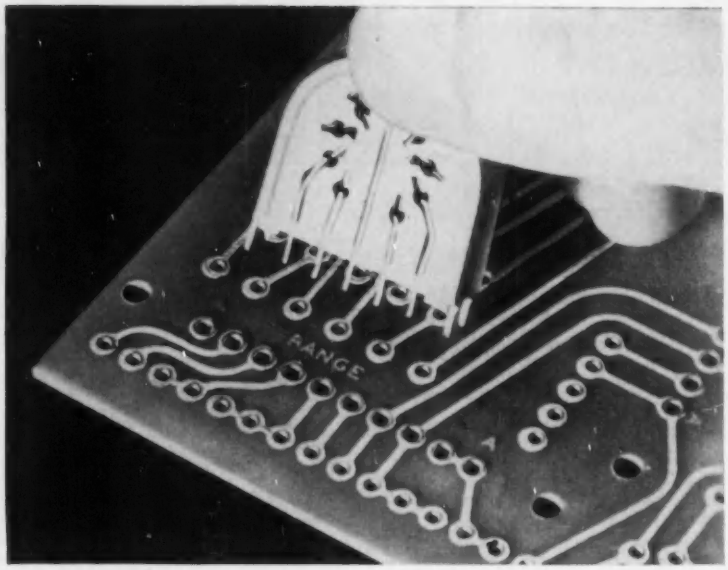
Switch With Solenoid-Operated Detent

This miniature solenoid toggle switch is said to be designed for severe environmental conditions. It is for use in systems which require a visual "on-off" indication. It consists essentially of a miniature micro-switch which is actuated by a toggle. The toggle is held in position by a solenoid-operated detent.

The switch is manually operated by flipping the toggle to "on" position. This energizes the solenoid, holding the toggle in position. The toggle can be returned to its normal or "off" position manually, or in the event of any failure of the system's circuitry, the solenoid is immediately de-energized and the toggle returned to its "off" position automatically.

Electrical rating: resistive load 2 amp, 30 v, dc; operating temperature range is −65 C to 71 C; dimensions are $1\frac{33}{64}$ x $1\frac{7}{16}$ x $\frac{33}{64}$ in; and weight, 3.6 oz. Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N. J.

For more information—
Circle 6, inside back cover



Right-Angle Tube Sockets For Printed Wiring

These tube sockets provide reduction in height and depth of printed-wiring assemblies. The sockets are equally adaptable to hand- or machine-insertion methods. Terminals are of adequate length to slip into printed wiring holes and be dip-soldered. Silver-plated contacts are engineered to provide nonfatiguing contact pressure with suitable insertion and withdrawal pressures. Metal parts and mounting hardware are plated to meet salt-spray test specifications.

These components are available in seven- and nine-pin sockets and in four different versions. Aerovox Corp., 2724 S. Peck St., Monrovia, Calif.

For more information—
Circle 7, inside back cover

Self-Checking Monitoring System

Successfully tested on fire detection systems, machine safety controls, furnace flame monitors, photocell intrusion alarms and liquid-level controls, a dynamic monitoring technique, which checks itself by unique pulsation, requires only a few additional components to change conventional static systems to self-checking design. The technique is sufficiently basic to be used with electronic, electrical, mechanical, pneumatic, hydraulic and nuclear systems.

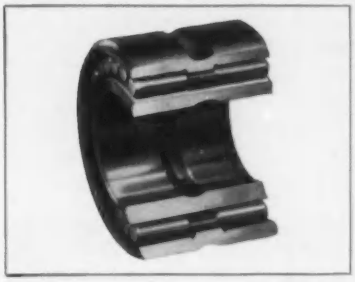
Protective devices and system monitors incorporating this method periodically check themselves by simulating the dangerous (unsafe) condition they are designed to detect. If the protective monitor responds properly to this simulated danger, it is sure to respond to the real danger when it occurs. An alarm suppression circuit is built into the monitor to hold off the warning signal during the short period of simulated danger. Actual failure of the safe condition being sensed or of the monitoring system itself

CONTINUED ON PAGE 234

BEARING TIPS by McGill

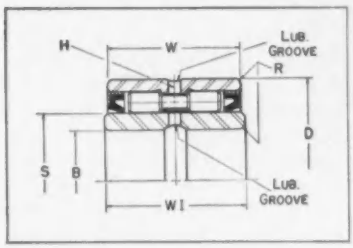
CAGELESS BEARING CORRECTS SKEWING

Guiderol Bearings carry greater loads in smaller spaces because they have no space wasting cages. A full complement of center grooved rollers extends the width of the race for maximum load support and a center guide rail avoids roller skewing that can bind a bearing under some loads. MT and CT series interchange dimensionally with ordinary needle bearings and cylindrical roller bearings.



First Sealed Full Type Roller Bearing Series

The SG series Guiderol bearing provides low-cost and flexible sealing where ordinary needle-type bearings with auxiliary seals have been too cumbersome and expensive. Interchangeable with the standard Guiderol bearing, the new SG series provides five sealing combinations.



140 Pages of Bearing Facts

Write for your copy of Catalog No. 52, a revised 140-page Bearing Selection Guide. It contains vital product information and 30 pages of engineering data.

GUIDEROL® BEARING CARRIES GREATER LOAD IN SMALL SPACE FOR McCULLOCH CHAIN SAWS

Bearings installed in 1944 still in use.

Load-carrying capacity in minimum space is given as the reason for using McGill Guiderol bearings on the heavy-duty loader made by the Farmhand Company. Four bearings support the shafts of the gear pump that furnishes hydraulic power to the loader. Guiderol bearings have been used by Farmhand since 1944 and virtually all of the loaders with the original bearings are still in use.

Assembly ease cited as an extra benefit

Rugged use in the field dictates rugged construction at the factory for McCulloch Motors Corporation gasoline engine chain saw units. The one-man and two-man chain saws must be light and compact but sturdy enough to operate at full capacity all day long.

Since switching to a McGill Guiderol Bearing as support for the crankshaft, McCulloch, like many machine builders, has proved that the Guiderol bearing provides the desired greater load capacity in small space and outlasts former units with minimum maintenance—important under rugged chain saw field conditions.

A bonus benefit is the ease of installation of the Guiderol bearing—with open ends and no end shoulders. Assembly is a simpler operation.

Insure performance with McGILL®

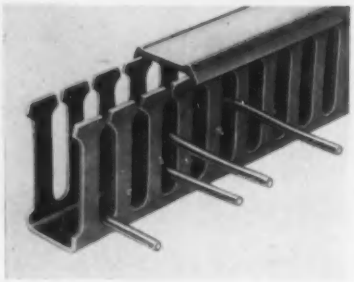
MULTIROL® GUIDEROL® CAMROL
Full Type Roller Bearings

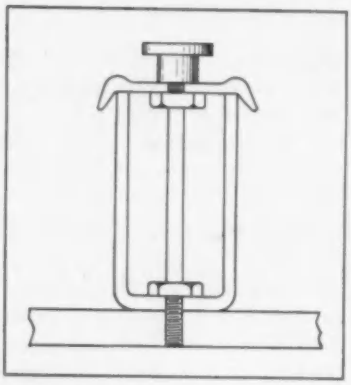
McGILL MANUFACTURING COMPANY, INC., 201 N. LAFAYETTE ST., VALPARAISO, INDIANA

halts the required safe-unsafe oscillation and sounds the alarm or initiates corrective action.

A photocell circuit designed to detect the absence of light is tested by periodically interrupting the light beam. A temperature monitoring system is tested by pulsing a heat source in the vicinity of the temperature detector. A nuclear radiation monitor can likewise be tested by periodically exposing a radioactive source near the sensing element. Scully Signal Co., Melrose, Mass.

For more information—
Circle 8, inside back cover





Control Panel Wiring Conduit

This wiring uses a conduit slot design which is said to reduce wiring time. It is available in a range of sizes from 1 x 1 in. to 3 x 3 in., in 5 ft lengths. Lugs can be attached before the wire is inserted, allowing the wire to be removed with lugs attached.

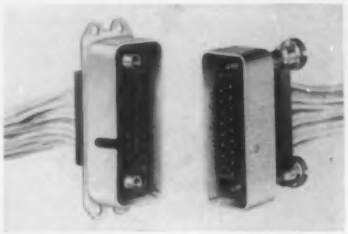
The fastener used with this duct holds both duct and cover and prevents either from slipping. Being an internal nut and bolt arrangement, it has no external projections, does not require space adjacent to the duct and in no way interferes with wire insertion. Panduit Co., Dept. PEN, 10132 S. Washtenaw Ave., Chicago 43, Ill.

For more information—
Circle 9, inside back cover

Hardened AISI 1060 Steel Bars

These long, round, hardened bars are for use as guide rods, shafts, rolls, piston rods, axles. Material is AISI 1060 steel, which has a surface hardness close to 60 Rc and is precision ground to standard diameters. Initial standard sizes range from ¼ to 4 in. dia. Length varies from 8 to 14 ft, depending on the diameter. Depth of hardness ranges from 0.040 in. min in the smallest diameter to 0.100 in. min in the largest. Thomson Industries, Inc., Manhasset, N. Y.

For more information—
Circle 10, inside back cover



External Miniature Connectors

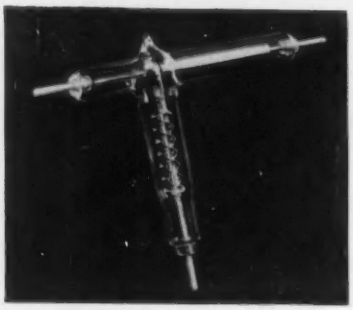
Polarized aluminum shells provide protection for the dielectric and contacts, and assure proper mating of pins and sockets. The connectors come in a variety of assembly combinations, including such accessories as: 1) a jackscrew locking device; 2) mounting plates for wall or bulkhead installations; 3) hoods or finger grips for cable-mounted applications. The connectors are available with 9, 14, 18, 20, 21, 26, 34, 42, 50 or 75 contacts, which are rated at 7.5 amp. Voltage breakdown between adjacent contacts at sea level is 4000 v, dc. Winchester Electronics, Inc., Dept. K, Norwalk, Conn.

For more information—
Circle 11, inside back cover

Tantalum Capacitor

Preliminary laboratory and field tests indicate favorable characteristics over a temperature range extending from −70 C to 85 C. The capacitor is particularly stable at low temperatures. From room temperature to −70 C, capacity and power factor are practically constant. This capacitor uses a porous sintered tantalum anode with an electrochemically formed tantalum oxide dielectric, which provides large capacity in small space with an exceptional chemical and electrical stability. Fansteel Metallurgical Corp., N. Chicago, Ill.

For more information—
Circle 12, inside back cover



High-Current Vacuum Switch

The switch was developed specifically for switching between spectrograph arc and spark sources, but has numerous other applications where a sealed, single-pole, double-throw relay capable of handling 30 amp at up to 250 v or low current at voltages up to 22,000 v or both, is required. Penta Laboratories, Inc., Santa Barbara, Calif.

For more information—
Circle 13, inside back cover

Offset Spinning of Tubular Aluminum Parts

This process is similar to those for spinning copper, but compensates for the different character of the two metals, making possible the spinning of aluminum in high volume production runs, both regular and in offset.

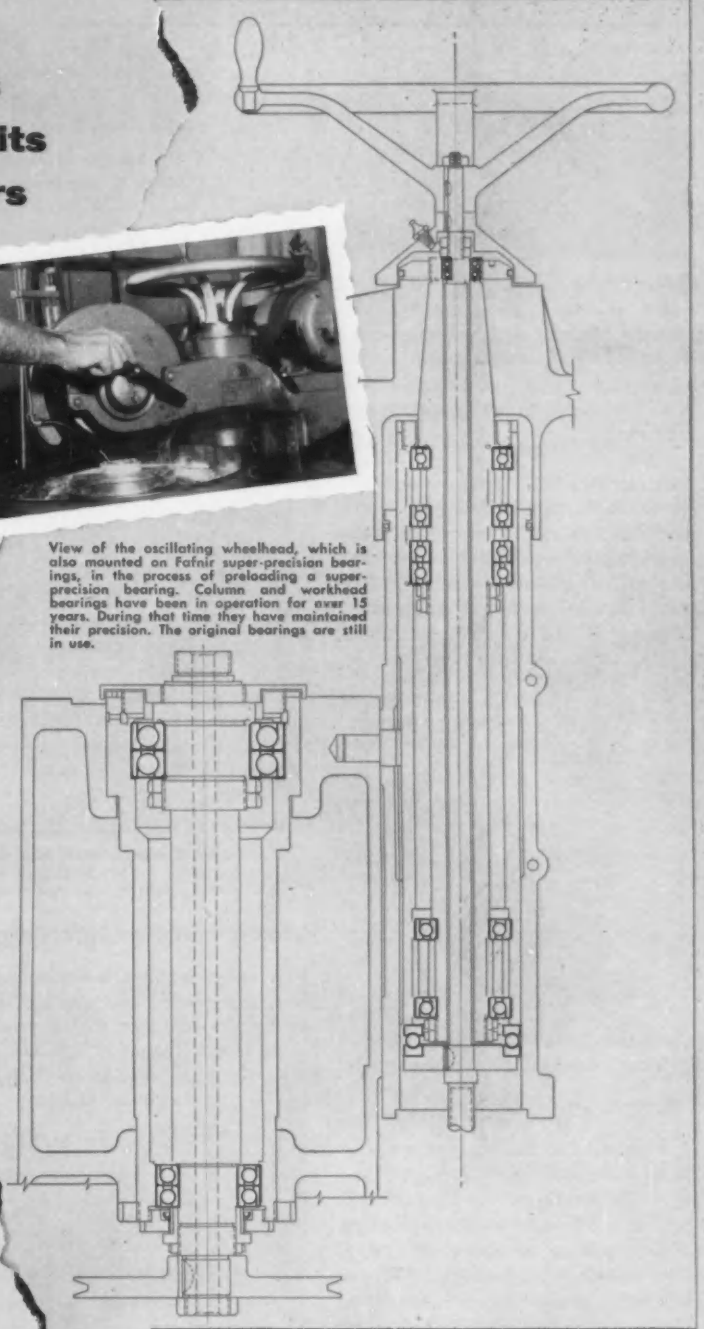
CONTINUED ON PAGE 236

How a precision surface grinder is designed to hold its precision for years

The job of preloading super-precision ball bearings calls for grinding precise amounts of stock from the faces of bearing rings. To obtain such results with a satisfactory degree of efficiency requires a grinder designed to maintain maximum rigidity and precise swiveling of its wheelhead arm plus precise rotation of its work spindle.

The diagram at the right shows how such rigidity is built into a precision surface grinder. All bearings indicated except the thrust bearing at the bottom of the column which supports the wheelhead arm are Fafnir super-precision, preloaded types. The use of these Fafnir ball bearings has resulted not only in work of dependable accuracy and finish, but also longer machine life. For other application data on Fafnir super-precision bearings plus dimensional and load rating details, write for Fafnir Precision Ball Bearing Catalog. The Fafnir Bearing Co., New Britain, Conn.

View of the oscillating wheelhead, which is also mounted on Fafnir super-precision bearings, in the process of preloading a super-precision bearing. Column and workhead bearings have been in operation for over 15 years. During that time they have maintained their precision. The original bearings are still in use.



FAFNIR

BALL BEARINGS

MOST COMPLETE LINE IN AMERICA

The spun aluminum process is said to make possible substitution of the cheaper metal in such automotive integrals as overflow and vent tubes, and other similar parts, as well as where a venturi effect is required, such as in carburetors.

The offset, or "angle", spin results in a formed end located anywhere off-center of the part being formed, without the necessity for kinking or bending operations. It applies to the necked end as well as inlet or outlet tubes connecting to the component. Whiting Tubular Products, Inc., 18300 James Couzens Highway, Detroit 28, Mich.

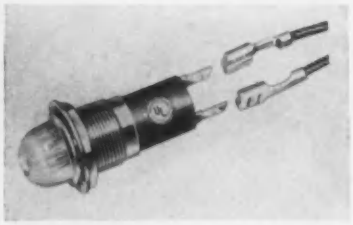
For more information—
Circle 14, inside back cover

Switch With "Serpentine" Action

This switch is said to provide movement differential less than 0.0005 in., for use in operations requiring extreme sensitivity. Since the switch has no pivot points, which can cause variation in snap, it has no dead center, no flickering. The low stress design eliminates drift at the trip points.

The mounting centers are the standard 1 in. apart. The switch has a 20-amp rating, and the manufacturer states that it is particularly adaptable to use in machine tools, appliances, vending machines, aircraft and in-plant uses. Seven different types of plunger, spring and lever actuaters are available. Licon Switch and Control Div., Illinois Tool Works, 2501 N. Keeler Ave., Chicago 39, Ill.

For more information—
Circle 15, inside back cover



Pilot Lights

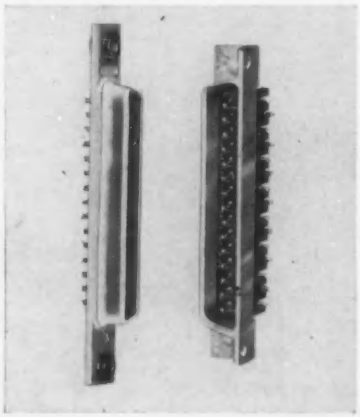
These lights have spade terminals to fit quick-connect type wire connectors. The connection is positive with triple-spring action.

This series, which mounts in an ½ in. clearance hole, offers a complete range of choice of screw and friction lens caps with lenses of varied shapes and colors. The incandescent bulbs which are used may be had in 2 to 55 v ratings. Dialight Corp., 60 Stewart Ave., Brooklyn 37, N. Y.

For more information—
Circle 16, inside back cover

Printed Circuit Connectors

The plug contains individually-isolated, right-angled pin contacts, one end for dip soldering to the printed circuit board, the other end for engaging the socket contacts of the mating receptacle. The receptacle, in turn, is used for attaching the external wires.



The connectors are available with 7, 11, 15, 19 or 23 contacts, which are machined from bar stock, and gold-plated over silver. Shells are aluminum and provide protection and polarization for the contacts. Voltage breakdown at sea level is 3900 v, dc. Current rating is 7.5 amp per contact. Winchester Electronics, Inc., Dept. K, Norwalk, Conn.

For more information—
Circle 17, inside back cover

Flanged Pipe Connector

This flexible flanged connector, in pipe sizes to 2 in. ID, provides a non-rigid take-off from engines, machines and equipment. Supplied with a conventional flange on one end, the other end has a rubber-packed compression seal which is reported to absorb vibration, expansion-contraction stresses and compensates for small misalignments or deflection in the connecting pipe or tubing. Dresser Manufacturing Div., Bradford, Pa.

For more information—
Circle 18, inside back cover

Liquid Spring

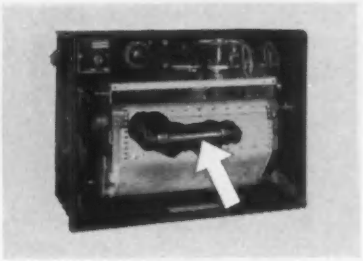
This combination spring and shock absorber incorporates an integral hydraulic levering principle which permits the development of spring forces as low as 600 lb with a 2 in. stroke, plus energy absorption as a shock absorber. Wide extremes of spring force are possible with the same components while maintaining sturdy piston members of any desired rigidity. Previously, for low spring forces, the small piston diameter of the liquid spring

CONTINUED ON PAGE 238

FLEXIBLE SHAFT IDEAS for ENGINEERS

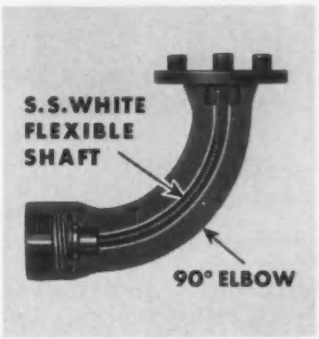
Flexible Shafts simplify manufacturing operations — lead to improved designs

Cost-savings possibilities are many when you design with these useful mechanical elements

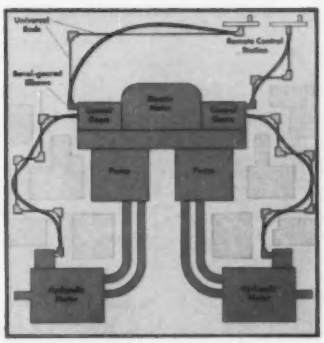


Giving alignment problems the "go-by"

NOT ONLY DOES a flexible shaft provide a vibrationless drive in this sensitive recording pyrometer, but it eliminates the need for accurate alignment of the connected spindles. The ability of a flexible shaft to operate under conditions of misalignment is a feature that is of extreme importance in many remote control and power drive installations.



A truck recorder drive in which a 3" flexible shaft replaced a set of bevel gears and straight shafts. Result: fewer parts, lower cost and elimination of failures caused by high starting torque of the gears.



4 standard flexible shafts replaced the 35 parts formerly used to control this dual hydraulic power unit. Result: a 90% cost savings and 100% improved performance.

NO OTHER SINGLE MECHANICAL ELEMENT solves power drive and remote control problems as simply and economically as an S.S.White flexible shaft.

Savings through Simplification

For instance, the ability of an S.S.White flexible shaft to operate around turns and under conditions of misalignment is a big help in simplifying drive or control setups. It means that a single flexible shaft can often be used in place of whole systems of bevel and worm gears, solid shafts, universals, etc. Naturally, with fewer parts to handle, production time and costs can be trimmed.

Improved Designs

Simplification is not the only advantage offered by an S.S.White flexible shaft. It gives greater leeway in locating coupled parts to insure greater efficiency, easier operation, greater compactness, or more attractive appearance.

Reduced Layout Time

Not the least of a flexible shaft's advantages, is the ease with which it can be applied. There are no gear ratios to work out—no alignment problems—no worries about tolerances on bearing and journal fits, about special machining, etc. And, the wide range of physical characteristics and sizes available, make it easy to meet a diversity of requirements.

Here is a bulletin every designer should have

Bulletin 5601 contains the latest information on flexible shafts. Included are full details on how to select and apply power drive and remote control flexible shafts as well as up-to-date tables showing flexible shaft sizes and characteristics. Send for a copy.

F6-4

FIRST NAME IN FLEXIBLE SHAFTS

S. S. WHITE INDUSTRIAL DIVISION, DEPT. D, 10 EAST 40th ST., NEW YORK 16, N.Y.

Western Office: 1839 West Pico Blvd., Los Angeles 6, Calif.

necessitated levering which limited its usefulness.

The unit is 7⅜ x 1⅜ in. dia, plus mounting stud. It delivers 8000 lb of spring force with a 1300 lb preload, with a 1 in. stroke. It is said to equal a combination of two 8 in. dia springs 7 in. long of 1 in. dia wire, plus two standard automobile shock absorbers each of the same diameter as this newly introduced liquid spring. Taylor Devices Inc., 188 Main Street, North Tonawanda, N. Y.

For more information—
Circle 19, inside back cover

Vinyl Insulating Tubing

In addition to colors, this tubing will also be available in clear form, which is transparent rather than translucent. This permits positive identification of wire coding without the necessity of tearing the insulation apart. UL-approved for temperatures up to 105 C, the new sleeving has flame resistance as well. Bentley, Harris Mfg. Co., Conshohocken, Pa.

For more information—
Circle 20, inside back cover

Fixed Voltage Supplies

These supplies are obtainable from 50v (±25v) to 375 v (±25v) in 25v steps, with current ranges of 0 to 1, 0 to 2, and 0 to 3 amp. Regulation can be either standard, 0.5 per cent or precision. 0.1 per cent. D-c outputs are adjustable within ±5 per cent. Universal Electronics Co., 1720-22 St., Santa Monica, Calif.

For more information—
Circle 21, inside back cover

A-c—D-c Digital Voltmeter

Reading time for the instrument averages 3 sec for a-c and 1 sec for d-c readings. Readings are made automatically and presented on a digital, in-line read-out. The 1-in. numerals can be read from 30 ft away, it is reported.

Range of the new instrument is 0.001 to 999.9 v. Range switching is manual on ac and automatic on dc. A-c accuracy is 0.1 per cent of full scale. D-c accuracy is ±one digit.

Frequency response of the new instrument is from 30 to 10,000 cycles at 10 megohm, 20 mmf. The response curve is flat over the full range. The instrument is designed for mounting in a standard 19 in. rack. Panel height is 10½ in. Electro Instruments, Inc., 3794 Rosecrans St., San Diego 10, Calif.

For more information—
Circle 22, inside back cover

Hydraulic Power Unit

This is a 500 psi power unit, made up of an electric motor (up to 1 hp), a vane-type pump (3, 6, 9, or 12 gpm) rated at 1000 psi, and a relief valve. All are mounted on a JIC, 10-gal reservoir, complete with mounted accessories (breather, filler cap and screen, oil level gauge, baffles) and three circuit return ports. Rosaen Company, P.O. Box 195, St. Clair Shores, Michigan.

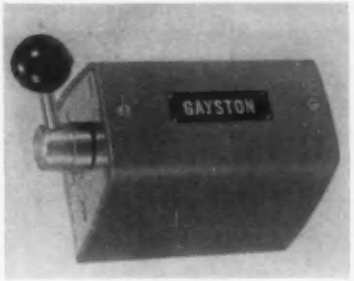
For more information—
Circle 23, inside back cover

Reversing Switch

This switch has silver-tipped contacts, berylium copper preloaded contact springs, molded contact block and barrier. Can be used on either maintained or momentary contact and is quickly converted without tools.

The mounting holes are designed to fit all standard brackets, and the unit is suitable for surface or panel mounting. Rated for 1½ hp, max, single-phase and 2 hp −600 v max, polyphase operation. Gayston Corp., 1225 Ray St., Dayton, Ohio.

For more information—
Circle 24, inside back cover



Pneumatic Transmitter

The instrument converts process temperatures from −375 F to 1000 F, or pressures of from 40 to 600 psi, to a standard of 3 to 15 psi output. Simple adjustments make it possible to measure temperatures or pressures and to vary the span width or shift it anywhere within the range of the instrument. The flexibility and accuracy of the new instrument is expected to make it valuable where close process control and versatility are required.

The new unit is shock mounted and designed to resist the effects of vibration. It compensates for ambient temperature and barometric pressure changes, eliminating the need for adjustment as these conditions change.

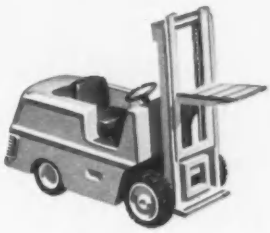
CONTINUED ON PAGE 240

MAKE IT WEIGH LESS

N·A·X

HIGH-TENSILE STEEL

MAKE IT LAST LONGER



You can design light weight, longer life, and economy into your products by including N-A-X HIGH-TENSILE in your plans.

- It is 50% stronger than mild steel.
- It is considerably more resistant to corrosion.
- It has greater paint adhesion with less undercoat corrosion.
- It has high fatigue life with great toughness.
- It has greater resistance to abrasion or wear.
- It is readily and easily welded by any process.
- It polishes to a high lustre at minimum cost.

And with all these physical advantages over mild carbon steel—it can be cold formed as readily into the most difficult shaped stamping.

When you next start to redesign, get the facts on N-A-X HIGH-TENSILE. It's produced by Great Lakes Steel—long recognized specialists in flat-rolled steel products.

N-A-X Alloy Division

GREAT LAKES STEEL CORPORATION

Ecorse, Detroit 29, Mich. • A Unit of

NATIONAL STEEL CORPORATION

The instrument operates on the force-balance principle which is said to virtually eliminate motion (on a full-scale deflection the primary element moves a few millionths of an inch). A small, highly sensitive stainless steel bulb provides fast response to temperature changes. Minneapolis-Honeywell Regulator Co., 4494 Wayne Ave., Philadelphia 44, Pa.

For more information—
Circle 25, inside back cover

Counts Dozens

Dozens are counted and registered automatically at speeds to 1000 counts per min. The counter continuously shows the number of dozens counted, as well as the less-than-dozen count, up to 100,000 dozen. Resets to zero with one turn of the reset knob.

The dozens counters are actuated by electric impulses the same as other electric counters. Available for practically any voltage up to 120 v, ac or dc. Overall dimensions, less reset knob, 2½ x 3½ x 1⅝ in. Production Instrument Co., 702-10 W. Jackson Boulevard, Chicago 6, Ill.

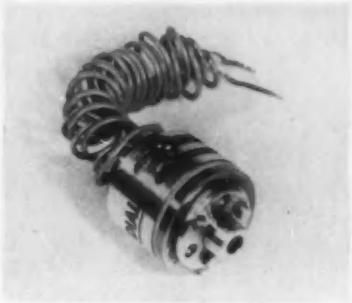
For more information—
Circle 26, inside back cover

Low Torque Single-Turn Potentiometers

These potentiometers are available in standard case sizes from ⅞ to 3 in. dia with a wide range of standard resistance values, between 100 and 600,000 ohm. Standard units have miniature precision ball bearings, however a more economical low-torque journal type bearing is available if desired. Either bearing may be incorporated in the tapped hole or optional servo mounting provided. Both linear and

non-linear windings and units can be provided with materials permitting operation at ambient temperatures up to 150 C. Circuit Instruments Inc., P.O. Box 355, 1927 First Ave S., St. Petersburg, Fla.

For more information—
Circle 27, inside back cover



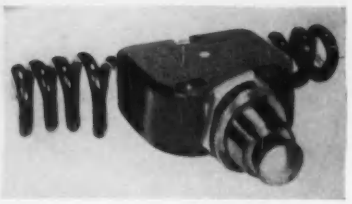
Tension Control Unit

This device provides fixed or variable tension control for applications such as fine wire winding, film reeling and high-speed thread winding. It can also be used in mechanisms where maximum torque transmission must be accurately controlled. Range of the device is 0 to 50 oz-in. The control is available in two sizes: Size 100 is 1⅛ x 1½ in. long. Size 130 is 1½ x 2¾ in. Dial Products Co., 9 Avenue E. Bayonne, N. J.

For more information—
Circle 28, inside back cover

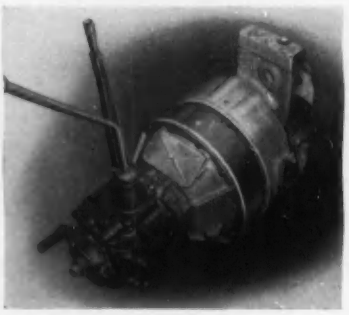
Push-Type, 6 Amp Switch

With 6-in. wire leads which are permanently attached to the switch terminals by pressure connections and measuring ⅝ in. thick, this switch is UL-approved. It carries a 6-amp



"T" rating at 125 v; 3 amp at 250 v. Stem diameter is ⅛ in., stem length ¼ in. McGill Mfg. Co., Inc., Valparaiso, Indiana.

For more information—
Circle 29, inside back cover



Hydraulic Coupling

This coupling is designed to transmit torque through a fluid, cushioning both engine and equipment from shocks of sudden load applications. It was developed for use on compressors, conveyors, blowers, cranes, crushers, pumps, winches, road equipment and other industrial applications. Continental Motors Corp., 205 Market St., Muskegon, Michigan.

For more information—
Circle 30, inside back cover

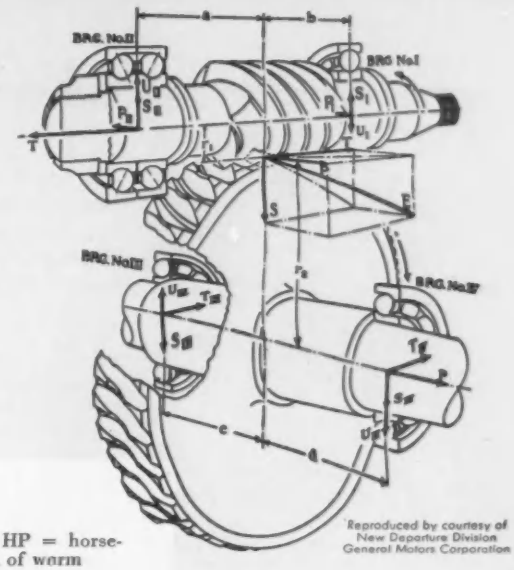
Double-Shaft ¾ Hp Motor

A ¾-hp, 3450-rpm, double-shaft motor, weighing 21 lb is said to be suitable for use in home and farm workshops, on bench saws, jointers, band saws, shapers, planers and grinders. It is also recommended for disc finishers, pumps, concrete mixers, feed mixers, milking machines, farm elevators, compressors and water systems where 3450 rpm speed can be used. Designed for operation on 115 v, the motor is of the capacitor type for hard-

CONTINUED ON PAGE 242

Helpful Data from
DE LAVAL

How to Calculate Worm Gear Bearing Loads



Reproduced by courtesy of New Departure Division General Motors Corporation

$Q = \frac{HP \times 63025}{N}$ = TORQUE INPUT to worm, lbs. inches; HP = horsepower transmitted and N = rev. per min. of worm

$P = \frac{Q}{r_1}$ = TANGENTIAL FORCE of worm, where

r_1 = Pitch radius of worm in inches
[r_2 = Pitch radius of worm gear
$= \frac{1}{2\pi}$ (number of teeth in gear x axial worm pitch)]

$S = \frac{P \tan \alpha}{\tan \gamma}$ = SEPARATING FORCE, where

α = Axial tooth pressure angle*
γ = Helix or lead angle of worm*
$= \tan^{-1} \frac{\text{lead}}{2\pi r_1}$, or $\tan^{-1} \frac{\text{Number of threads x axial worm pitch}}{2\pi r_1}$

$T = \frac{P}{\tan \gamma}$ = WORM THRUST, or tangent force driving worm gear

* LEAD ANGLE 0°-35° use 27½° Pressure Angle
LEAD ANGLE 35°-45° use 30° Pressure Angle

BEARING LOADS

Due to	on Brg. I	on Brg. II
P	$P \frac{a}{a+b} = P_I$	$P \frac{b}{a+b} = P_{II}$
S	$S \frac{a}{a+b} = S_I$	$S \frac{b}{a+b} = S_{II}$
T	$T \frac{r_1}{a+b} = U_I$	$T \frac{r_1}{a+b} = U_{II} = U_I$
Total Rad. Load	$\sqrt{P_I^2 + (S_I - U_I)^2}$	$\sqrt{P_{II}^2 + (S_{II} + U_{II})^2} = R_{II}$
Thrust Load		T
Total Load	$\sqrt{P_I^2 + (S_I - U_I)^2}$	$\sqrt{R_{II}^2 + T^2}$

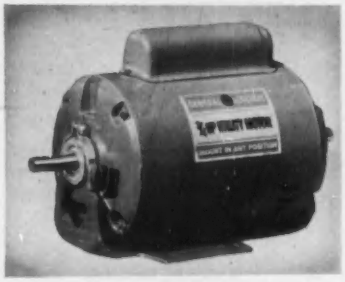
Due to	on Brg. III	on Brg. IV
P	$P \frac{r_2}{c+d} = U_{III}$	$P \frac{r_2}{c+d} = U_{IV} = U_{III}$
S	$S \frac{d}{c+d} = S_{III}$	$S \frac{c}{c+d} = S_{IV}$
T	$T \frac{d}{c+d} = T_{III}$	$T \frac{c}{c+d} = T_{IV}$
Total Rad. Load	$\sqrt{T_{III}^2 + (U_{III} - S_{III})^2}$	$\sqrt{T_{IV}^2 + (S_{IV} + U_{IV})^2} = R_{IV}$
Thrust Load		P
Total Load	$\sqrt{T_{III}^2 + (U_{III} - S_{III})^2}$	$\sqrt{R_{IV}^2 + P^2}$

Speed Change

$$\text{Gear rpm} = N \times \frac{\text{Number of threads in worm}}{\text{Number of teeth in gear}}$$

For simplicity in bearing load computations for worm gearing, the normal tooth force E is treated in terms of its three perpendicular elements, namely, P, the tangential driving force at pitch radius of worm; S, the force tending to separate worm from the gear, due to the pressure angle; and T, the thrust produced by the lead or helix angle of the worm.

Catalog 5000 contains helpful worm gearing application and specification data. Write on your business letterhead to the De Laval Steam Turbine Company, 801 Nottingham Way, Trenton 2, N. J.



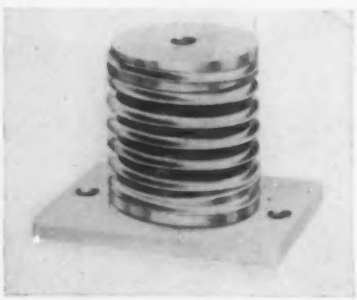
to-start loads, giving 2½ times full-load power for starting. It will carry momentary running loads up to 2 hp. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 31, inside back cover

Controls for Printed Circuits

A 2-w, wire-wound control with terminals that facilitate mounting and connections measures 1⅛ x ⅞ in. deep. It is available with or without tap. The tap is mechanically positioned 180 deg from center terminal, but can be electrically positioned to any percentage of resistance desired. Resistance values are from 1 to 50,000 ohm. Clarostat Mfg. Co., Inc., Dover, N. H.

For more information—
Circle 32, inside back cover



Low Frequency Mount

These vibration mounts are made of stainless steel wire, and are asserted to provide effective resilience with a high degree of damping. Designed for a static load deflection of 2½ in., this mount has overload protection built in. Excellent stability is assured for the mounted equipment in conjunction with a very low natural frequency of 2 cps, to isolate the full range of motor vibration and noise or to eliminate disturbance in the vicinity of the machinery. Vibration isolation is 85 per cent and better at 6 cps and over.

For fluid pumps, air compressors, refrigeration equipment and laboratory machinery operating at low motor speeds, this mount can be adapted to hanger types of application. Robinson Aviation, Inc., Teterboro, N. J.

For more information—
Circle 33, inside back cover

Heat Resisting Diaphragms

Convolute diaphragms for applications involving temperatures up to 300 F are being produced in sizes up to 30 in. dia. Molded with a single ply of high tensile fabric, these diaphragms are thinner and lighter in weight and require less operating power when used in hydraulic or pneumatically operated controls on dryers, or valves located in hot areas.

Most sizes are suitable for working pressures up to 100 lb. Stowe-Woodward, Inc., Newton Upper Falls 64, Mass.

For more information—
Circle 34, inside back cover

Two Hose Fittings

A brass push-on fitting for low pressure use on machine tools or for shop air, water, fuel, or lubrication lines, comes in ¼, ⅜, and ½ in. sizes, and is designed for use with a rubber-covered hose for a wide variety of low pressure uses up to 250 psi. The fitting is assembled dry or with water as a lubricant merely by pushing the hose over twin ferrules on the fitting stem.

Made in six types—rigid male pipe; swivel female SAE 45-deg flare; swivel female SAE 37-deg flare; swivel male inverted nut; rigid male SAE 45-deg flare; and rigid female inverted fittings.

The clamp fitting, for high pressure, heavy duty applications, is made of heavy malleable iron and is secured by two large heat-treated bolts. It is a reusable fitting made in eight sizes to accommodate hose from ¼ to 2 in. dia. This fitting is rated for pressures up to 3000 psi with triple wire hose; with double wire hose, it is also rated up to 3000 psi; with single wire hose it has a 2500 psi rating; and used with two fiber braided hose, it is rated for service up to 1500 psi. Flex-O-Tube Div., Meridan Corp., 2525 Jim Daly Road, Inkster, Mich.

For more information—
Circle 35, inside back cover

Subminiature Clutch

This clutch has a positive-displacement drive that transmits up to 15 in.-oz of torque at speeds to 1800 rpm without external lubrication and at higher speeds in an oil bath. The clutch is an all-purpose model that can be used for any single-revolution, over-running, non-reversing or indexing application within its capacity. The unit has an extremely low moment of inertia, 93.0 x 10^{-7} in.-oz/sec^2, making it ideal for any application requiring fast response under high loading. Maximum drag torque is 0.5 in.-oz.

The clutch is 1¼ x $\frac{5}{16}$ in. It is avail-

CONTINUED ON PAGE 244

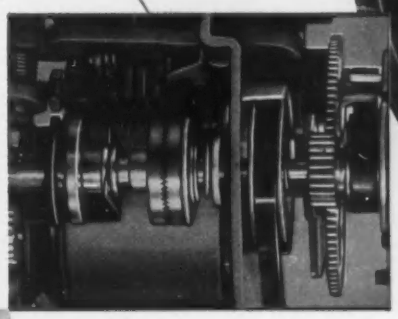
NEW

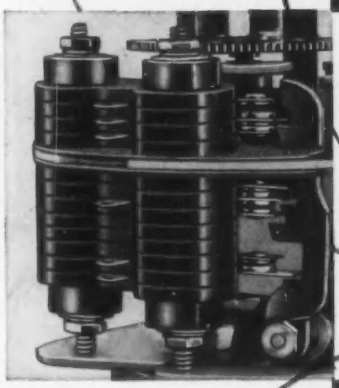
from face to terminal block

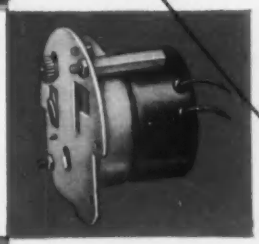
Cramer

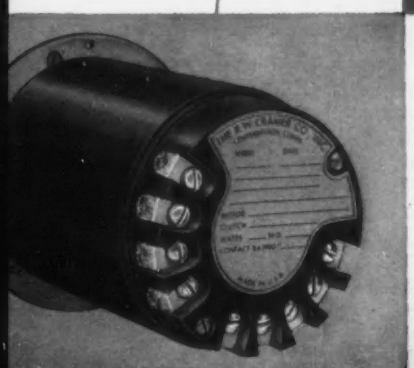
type 412

TIME DELAY RELAY









NEW—Repeat Accuracy within ± ¼ of 1% of full scale (30 sec. and longer ranges); ± ½ of 1% on faster timers.

NEW—Full Vision Dial. 300 degree scale assures precise settings and fast, accurate readings. Dial and pointers protected by transparent cover.

NEW Contacts, rated 15 amps., give positive quick-make, quick-break operation. Contacts are of silver cadmium oxide with ability to handle high inrush currents.

NEW Flexibility in wiring. Nine-position terminal block offers side or rear connection, presents a variety of wiring possibilities.

NEW Reset Shock Spring Design laboratory tested for more than a million operations.

NEW Friction Setting Mechanism allows adjustment even while timer is operating.

NEW—Ratchet Clutch operated by powerful relay, provides instant action, no slip.

NEW O-Ring Retainer permits quick removal of bakelite housing, exposing entire timer mechanism.

Timer driven by high torque (30 in. oz. at 1 r.p.m.) Cramer Type 112 Synchronous Motor.

Cramer TIMING DEVICES

The R. W. CRAMER CO., Inc.

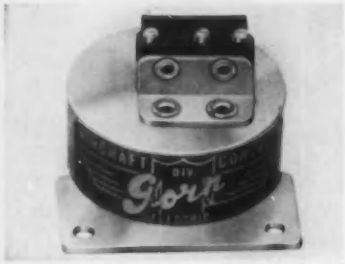
SPECIALISTS IN TIME CONTROL

BOX 7, CENTERBROOK, CONNECTICUT

14CRB

able from stock with either a coupling-end or through-shaft mounting. Precision Specialties, 1342 E. 58 St., Kansas City 10, Mo.

For more information—
Circle 36, inside back cover



Miniature Altitude Switch

This is a miniature barometric pressure switch for instantaneous, automatic control of aircraft electric or electronic circuits. It can be pre-calibrated to automatically open or close a circuit at any altitude from 1000 to 50,000 ft, with an unusually small differential. The unit weighs only 1¾ to 2 oz. Gorn Electric Co., Inc., Stamford, Conn.

For more information—
Circle 37, inside back cover

Miniature, High-Temperature Capacitors

Round or flat, these capacitors are available in capacities of 1 to 10 mmf. Working voltages are 50, 100, 150, 200, 250, 300, 400 and 600 v. Operating range is from −65 C to 200 C Only slight voltage derating is required above 150 C. Capcon, Inc., 25 Willett St., New York 2, N. Y.

For more information—
Circle 38, inside back cover

Rigid PVC Pipe

Two types of PVC pipe are being offered, a normal impact grade with high chemical resistance, and a high impact grade with slightly less chemical resistance but much greater strength. Threaded and socket types of fittings are available. They can be formed, sawed, threaded, machined, hot gas welded and solvent cemented.

Available in Schedules 40 and 80 in nominal sizes ranging from ½ to 4 in. All pipe is furnished in standard 10 and 20 ft lengths with plain ends. Carpenter Steel Co., Union, N. J.

For more information—
Circle 39, inside back cover

Switchboard Clock

The clock consists of a synchronous self-starting motor with sweep second hand. A front reset knob is provided, and connections are made to two studs on the rear. Clocks are 60 cps, and are available in 120 and 240-v models.

An additional clock-operated timing switch, which can be set from the front, is available for closing a circuit, such as process timing or an audible alarm. A front panel knob places the external circuit in on-off or automatic. Switch contacts are rated at 15 amp, 125 v, ac. Sunshine Scientific Instrument, 1810 Grant Ave., Philadelphia 15, Pa.

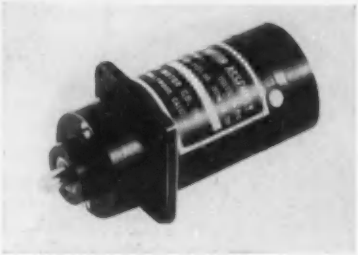
For more information—
Circle 40, inside back cover

Gage for Dangerous Installations

A solid front protects the gage face and a thin stainless plate, covering the entire back of the case, relieves all explosive pressures. The back plate is fastened to the case by two holding screws.

In experimental tests, blank cartridges were fired into the gage, subjecting the case to extremely high explosive pressures. The glass face didn't crack. The thin metal back plate folded outward and all the force was safely exhausted out of the back of the case. Jas. P. Marsh Corp., 3501 W. Howard St., Skokie, Ill.

For more information—
Circle 41, inside back cover



Miniature Planetary Geared Motor

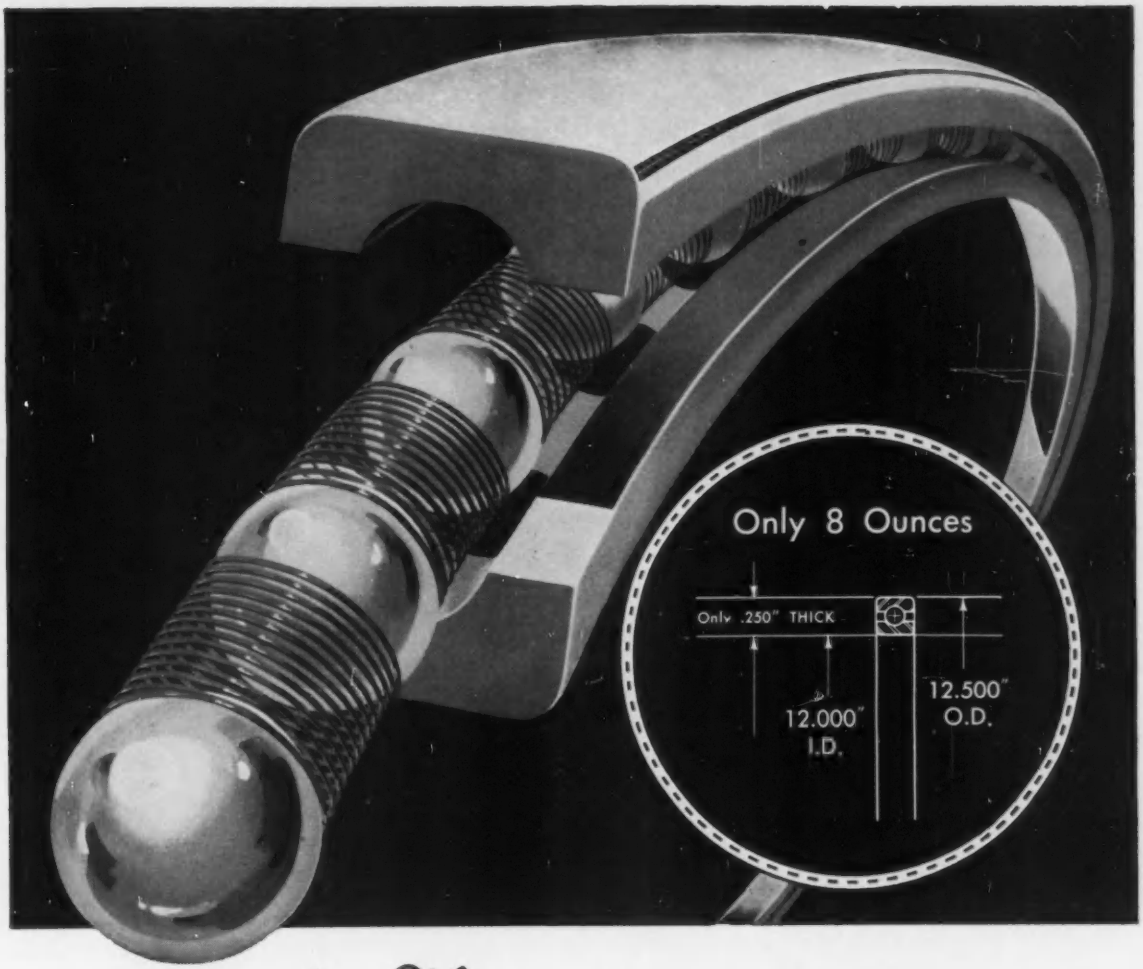
A d-c, fhp motor with brake has an output of 1 in.-lb. Stopping angle of output shaft is 3 deg, max. Rated for continuous duty at 25-29 v, dc, 400 amp, length from mounting flange is 2 in. and weight is 7¼ oz. El Ray Motor Co., Inc., 11747 Vose St., N. Hollywood, Calif.

For more information—
Circle 42, inside back cover

Ground Detector

This lamp-type ground detector uses lamps in place of voltmeters to indicate a ground in a 120-v, three-phase, three-wire circuit. Under normal conditions, each lamp will glow dimly on phase voltage. If a ground occurs, the lamp connected to the

CONTINUED ON PAGE 246



Reali-Slim... by Kaydon
world's thinnest radial ball bearing

HERE'S a typical example of Kaydon's *Reali-Slim* unique radial ball bearing that's finding wide application in practically every industry. *Reali-Slim* are the world's finest thin-section bearings and proportionately are thinner than a wedding ring. The bearing illustrated here is 12.000" I.D., 12.500" O.D., .250" thick — weighs less than 8 ounces. Designed for minimum weight and space limitations, it has a static load capacity of 5,520 lbs. and 894 lbs. at 100 rpm.

If you're looking for *Reali-Slim*, lightweight, radial ball or roller bearings, look at Kaydon's *Reali-Slim* line. Besides hundreds of standard *Reali-Slim* designs, there's a wide variety of special races, seals and separators to meet special bearing problems. What's more Kaydon is able to produce these *Reali-Slim*, high-precision bearings because Kaydon specializes in the unusual. In addition, Kaydon bearing engineers are prepared to give you valuable help with technical bearing application problems.

For complete data on *Reali-Slim* bearings for standard or special applications, ask for engineering Catalog No. 54RS-2.

***Reali-Slim* Ball Bearings** — in Conrad, angular contact, 4-point contact and other types are available in seven standard cross sections from .250" to 1" and in bore diameters from 4" to 40".

***Reali-Slim* Roller Bearings** — in radial or taper roller types are available in cross sections from 3/16" and in bore diameters from 5" to 40".

K-554

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

All types of ball and roller bearings — 4" bore to 120" outside diameter . . .

Taper Roller • Roller Thrust • Roller Radial • Bi-Angular Roller • Spherical Roller • Ball Radial • Ball Thrust Bearings

now

you can get this brilliant finish directly on zinc die castings!

No electroplating--no mechanical finishing!

PART AS CAST

TREATED WITH NEW IRIDITE

NEW IRIDITE® (Cast-Zinc-Brite)

brightens zinc die castings by chemical polishing, protects against corrosion

NOW, FOR THE FIRST TIME you can get a brilliant, decorative finish directly on zinc die-cast parts . . . without mechanical finishing, without electroplating! The luster is provided by the *chemical polishing* action of new Iridite (Cast-Zinc-Brite) solution. Even surface blemishes, such as cold shuts, are brightened by this new process. No electrolysis. No special equipment. No specially trained personnel. Just a simple chemical dip for a few seconds and the job is done. And, this new Iridite has been *tested and proved* in production.

CORROSION RESISTANCE, TOO! New Iridite (Cast-Zinc-Brite) provides exceptional corrosion resistance for bright-type chromate finishes . . . also guards against blueing or darkening by eliminating zinc plate formerly required in bright chromate finishing of zinc die castings.

AS A BASE FOR ELECTROPLATING—Lower mechanical finishing costs are possible where plated finishes are *required* since the brightness provided by this new Iridite may be sufficient.

LET US SHOW YOU what Iridite (Cast-Zinc-Brite) can do for you. Send us at least a half-dozen typical zinc die-cast parts for FREE PROCESSING for your own tests and evaluation. Or, for immediate information, call in your Iridite Field Engineer. He's listed under "Plating Supplies" in your classified 'phone book. *IMPORTANT: when you give us samples for test processing, please be sure to identify the alloy used.*

Iridite is approved under government specifications

ALLIED RESEARCH PRODUCTS
INCORPORATED
4004-06 E. MONUMENT STREET • BALTIMORE 5, MD

Manufacturers of Iridite Finishes for Corrosion Protection and Paint Systems on Non-Ferrous Metals; ARP Plating Chemicals

grounded line will go out completely, and the other two lamps will burn brightly, thereby indicating full line-to-line voltage. Sunshine Scientific Instrument, 1810 Grant Ave., Philadelphia 15, Pa.

For more information—
Circle 43, inside back cover

Self-Aligning Bearing

Continuous self-alignment, even during operation, of variations up to ½-in. per foot of distance between bearing centers is claimed. A nylon corrosion insulator, which prevents the unit from corroding to the shaft, eliminating bearing pullers and shortening maintenance and overhaul time.

The bearing was designed initially for farm equipment and can be used in a great variety of equipment, such as construction machinery, blower fans and conveyors. The unit comes completely assembled in two basic sizes, covering a range of shaft diameters from ¾ to 1⅜ in. Cleveland Graphite Bronze Co., 17000 St. Clair Ave., Cleveland 10, Ohio

For more information—
Circle 44, inside back cover

Vibration Resistant Nuts

The upper portion of this nut has a V-type notch with the circumference of the barrel compressed inwardly toward the axis to form a permanent set. This makes it a re-usable, prevailing torque-type, self-locking nut. It is a one-piece, self-contained unit in which the self-locking device is an integral part of the design. No non-metallic materials or stamped parts are used. Can be manufactured in brass, bronze, stainless steel, aluminum with unified screw threads,

(Continued on page 251)

Design "Low Cost" Into YOUR Equipment

GITS

World's Largest Selection of Low-Cost Lubricating Devices

LUBRIKIT . . . An assortment of 95 oil cups of 29 different types. Gits sales records show these oilers are most used for replacement and maintenance. Contents of each separate bin are clearly described on Inside Cover.

Special Introductory Price
Just **$14.95** F.O.B. Factory
Satisfaction or your money back

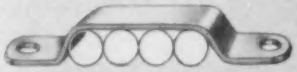
CLIPS FOR ATTACHING TUBING

When ordering, specify ¼", 5/16" or ⅜" tubes. Style TF.

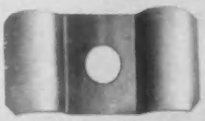
Single Clips

Double Clips

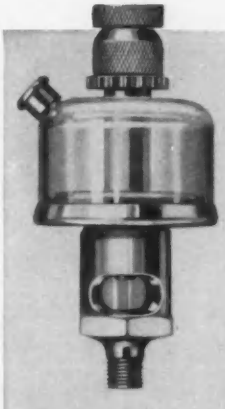
3-Tube Clips



4-Tube Clips



Double Clips — Wing Type

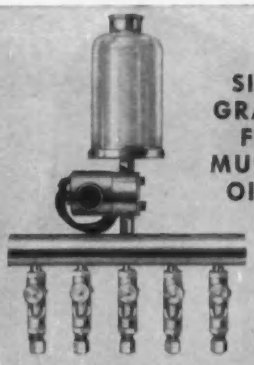


SIGHT GRAVITY FEED OILERS

Rate of oil flow regulated by needle valve, directly observed through sight glass in stem. Shut-off knob does not affect needle valve adjustment. Visible oil supply. Non-breakable. Tops in convenience and dependability, at low cost. Style NFU—No. 3602-A.

GEAR CASE GAUGES

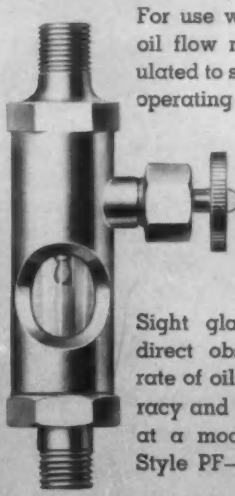
This oil gauge plug permits instant checking of oil level within a transmission or gear case. For use where construction permits insertion in tapped hole. A valuable addition to any such equipment — at very low cost. Style BW—No. 4042.



SIGHT GRAVITY FEED MULTIPLE OILERS

This one unit replaces 3 to 8 individual oilers. Maximum practicality in a small central lubrication system. Positive cut-off during idle periods. Individual vibration-proof needle valve adjustments. With solenoid control (Illustrated): Style MDS—No. 4685-A. Without solenoid: Style MD.

SIGHT GAUGES



For use where rate of oil flow must be regulated to suit changing operating conditions. Needle valve permits extremely accurate adjustment of oil feed. Sight glass provides direct observation of rate of oil flow. Accuracy and convenience at a moderate price. Style PF—No. 4290.

Don't price yourself out of the market. When you design proper lubrication into your equipment, specify GITS Lubricating Devices—the widest selection available anywhere. The items pictured above are only a few of our many thousands of lubricating devices. At the design stage, get the GITS story. Free Engineering Service. Send NOW for your free Catalog.

GITS BROS. MFG. CO.

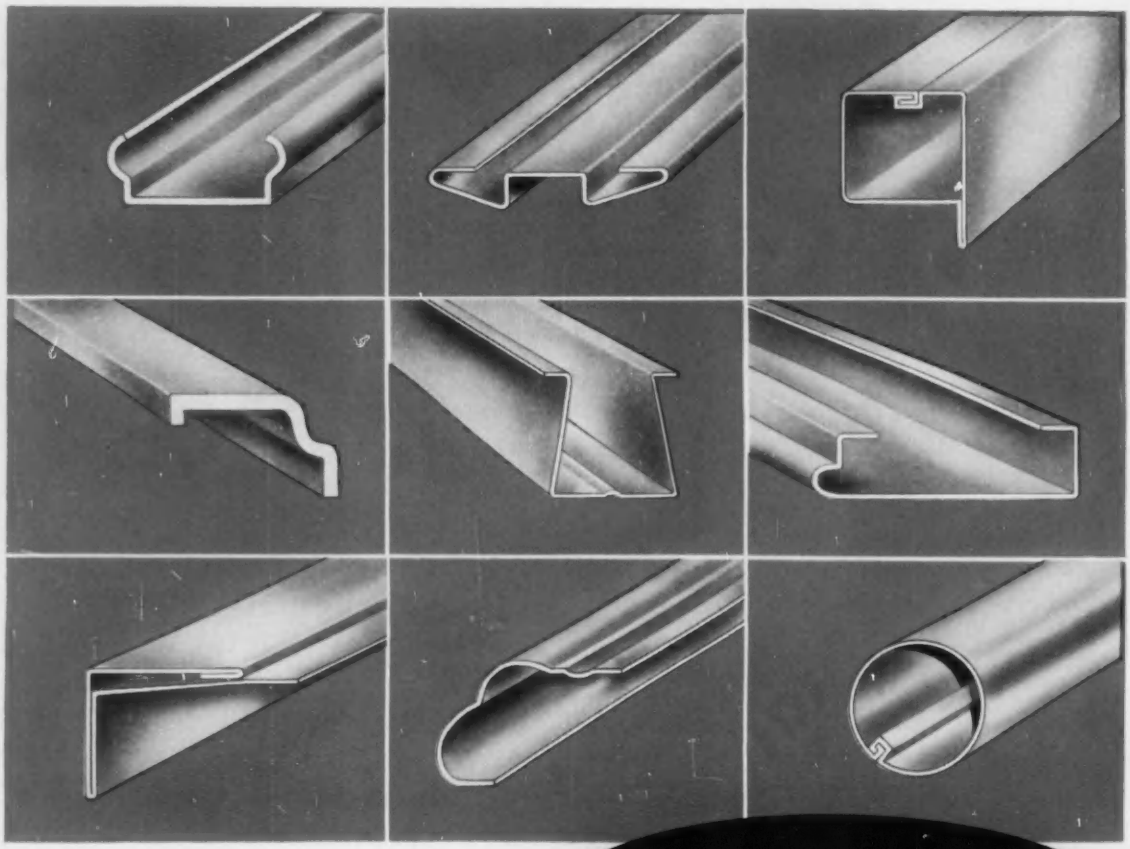
The Standard For Industry For Almost Half A Century

1838-A South Kilbourn Avenue
Chicago 23, Illinois

Clip this page for handy "rough reference"

INCREASE YOUR PRODUCTION WITH ROLL FORMED SHAPES

. . . carbon, galvanized and stainless steel; aluminum, copper, brass, zinc and clad metals delivered accurately punched, notched, bent and cut for final assembly.

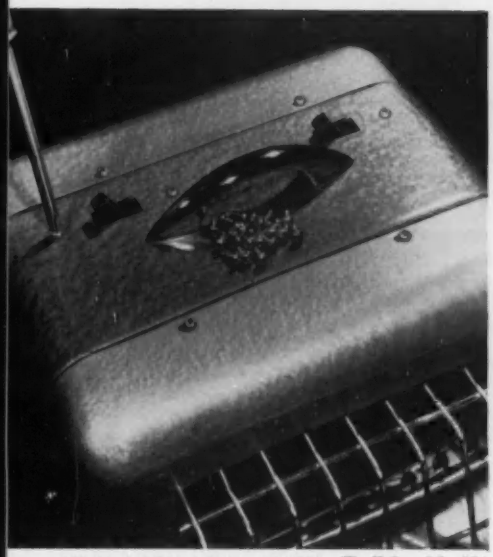


ROLL FORMED PRODUCTS
COMPANY

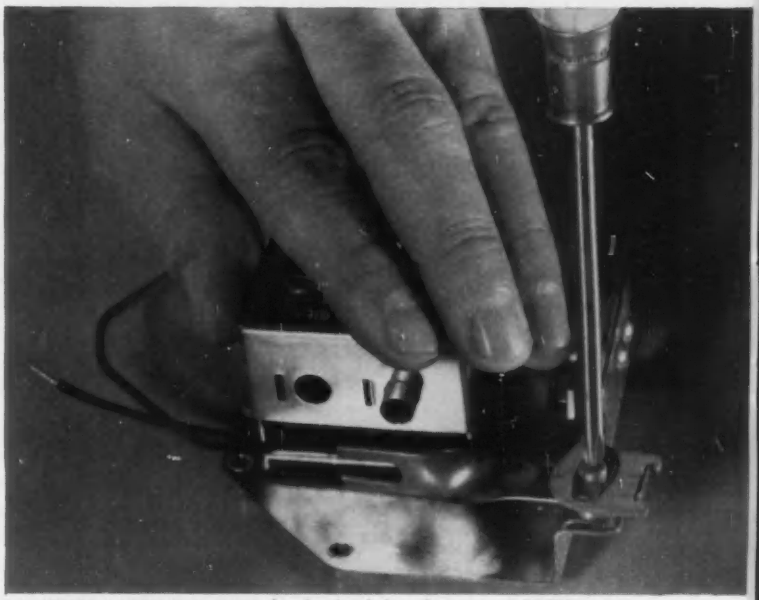
Let us help you increase production and lower costs. It can be done simply by changing to Roll Formed shapes which are formed, notched, pierced and cut to length in one continuous operation. We meet your most exacting specifications. Our accuracy cuts valuable man-hours from your final assembly costs. We're equipped to deliver Roll Formed shapes up to .125" thickness on schedule by the hundreds of thousands. Send your sketch or blueprints for prompt quotation. For details on our production facilities and techniques, ask for Catalog No. 1555. Do it today!

MAIN OFFICE AND PLANT • 3756 OAKWOOD AVE. • YOUNGSTOWN, OHIO

What Design Engineers Say About PHILLIPS CROSS RECESSED HEAD SCREWS



TITAN THERM-O-DIAL HEATER (Buffalo, N. Y.) is in a highly competitive market where appearance is important. Designer says, "We get a much tighter metal-to-metal bond, yet utilize a full mass-production assembly, which we could only do with Phillips screws."



"A BETTER LOOKING FIXTURE is obtained by the use of Phillips cross-recessed-head screws on our 8-Tone chime," says the chime engineer of Nutone Incorporated of Cincinnati, Ohio. "If screws must be used on the exterior of any unit, I definitely feel Phillips recessed-head screws are the very best choice."

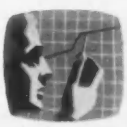
PUSH-BUTTON STATION by Clark Controller Company, (Cleveland) must indeed be bright as a button and unmarred. Says design head, "We selected Phillips screws because they permit easy assembly with driver slippage reduced to a minimum."

MANUFACTURERS OF PHILLIPS CROSS-RECESSED-HEAD SCREWS

THE FASTENERS OF TODAY...
AND OF THE FUTURE
***X* marks the spot**
the mark of extra quality

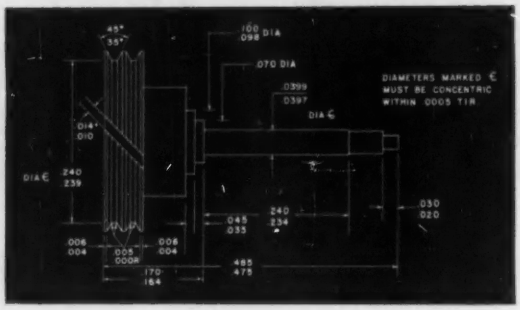
Pledged to highest standards...

The Phillips Screw manufacturers listed here cooperate to turn out a uniformly high standard of quality. As sponsors of the Phillips Cross-Recessed-Head Standards Committee they adhere to the established dimensional standards, gauges, and gauging methods which will best serve industry.

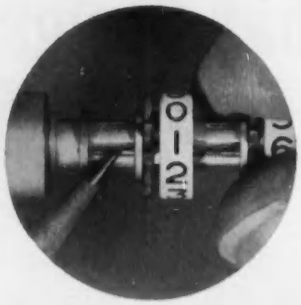


Members of Screw Research Association

American Screw Company • Atlantic Screw Works, Inc. • The Blake & Johnson Co. • Central Screw Company • Continental Screw Co. Elco Tool and Screw Corporation • Great Lakes Screw Corp. • The H. M. Harper Company • The Lamson & Sessions Company • National Lock Company • The National Screw & Manufacturing Company • Parker-Kalon Division, General American Transportation Corporation Pheoll Manufacturing Co. • Scovill Manufacturing Company • Shakeproof Division Illinois Tool Works • The Southington Hdwe. Mfg. Company • Sterling Bolt Company • Wales-Beech Corporation



Inspection of incoming precision shafts took 10 to 15 minutes each by mechanical gaging—involved concentricity, diameters, shoulder locations, and other tough-to-measure dimensions to tolerances of .0002". Doing the work on a Kodak Contour Projector cut time to 2 to 3 minutes per shaft.



The problem was to check many small calculating machine parts averaging about 13 critical dimensions for each with shapes mostly complex. With carefully engineered mechanical gages, inspection time averaged 50 seconds each. Optical gaging on a Kodak Contour Projector brought the average down to 12 seconds.

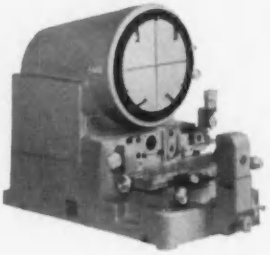
Spacing the parallelism of a special tuning condenser for electronic test equipment had to be held to very close tolerances. "Use of the Kodak Contour Projector," the company reports, "permits economical measurements of parallelism to an accuracy impossible to obtain by other methods."

On a flexible rubber-like part, rejects ran as high as 30%. By using a Kodak Contour Projector to measure the parts and then plotting results by statistical quality control methods, production changes were made that resulted in rejects dropping from 30% to less than ¼ of 1%. Optical gaging eliminated distortion of the part while gaging, and proved 4 to 5 times faster than usual methods.

One instrument inspects these varied parts

Here is another economy optical gaging can provide: switching from one part to a second part requires only a change of chart and fixture. You still use the same basic instrument. And with a Kodak Contour Projector, the variety of parts you can check is almost without limit. Here's why:

1. *Capacity*—Screen size on an optical comparator does not restrict the size of parts you can handle, for multiple-position fixtures allow the handling of parts larger than the screen itself. What's important is the staging area—and Kodak's unique relay lens provides uniform ample clearance regardless of magnification. The distortion-free image lets you measure anywhere on the viewing screen. The choice of lenses, of horizontal or vertical projection, and of surface or shadow illumination gives you the greatest possible flexibility.
2. *Ease of operation*—Kodak Contour Projectors are designed for maximum speed and minimum operator training. The bright screen image reduces fatigue, lets you use the instrument in normal room light. Images are erect and unreversed at all magnifications. Finger-tip controls are within convenient reach of the operator.
3. *Optical stability*—The adjustment-free optical elements on Kodak Contour Projectors eliminate the need for operator adjustments. Rigidly mounted lenses and mirrors maintain alignment and position. Rugged construction withstands rough and heavy use.



Whether you are now using optical gaging or just considering it, you should have a copy of the booklet, "Optical Gaging with Kodak Contour Projectors." It gives complete details on Kodak optical gaging equipment and how it can work for you. Write to *Special Products Sales Division.*

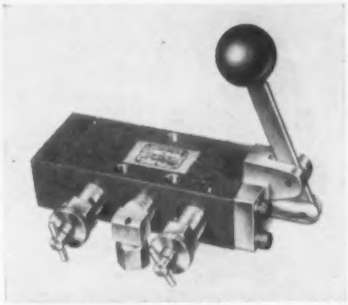
EASTMAN KODAK COMPANY, Rochester 4, N. Y.

the KODAK CONTOUR PROJECTOR

Kodak
TRADE-MARK

class 2B, in both coarse and fine thread series. Carr Fastener Co., Div. United-Carr Fastener Corp., Cambridge 42, Mass.

For more information—
Circle 45, inside back cover



Throttling Valve

A throttling-type valve to mount directly in control valve exhaust ports is made in ¼, ⅜ and ½ in. pipe thread sizes. It is machined from brass bar stock. Valve screws into either or both exhaust ports of a five-port, four-way valve to provide speed control of air cylinder piston in one or both directions, or into exhaust port of a three-way valve to regulate piston return speed on a single-acting cylinder. Modernair Corp., 400 Preda St., San Leandro, Calif.

For more information—
Circle 46, inside back cover

Silicon Photoelectric Cells

Miniature silicon photoelectric cells measuring 1 x 9/32 in. thick are made from silicon wedges encased in clear lucite with terminal plugs that fit into a standard octal socket. These cells are said to operate on infrared radiation and to provide rapid response, resistance to moisture, performance

(Continued on page 255)

HAGEN count switch

PAID FOR BY SAVINGS MADE ON JUST 1 TOOL

Simply set this Hagen Count Switch to the number of operations at which a tool should be changed. The count switch trips a switch after a preset number of electrical impulses . . . and thereby shuts down the machine automatically. Tool wear never reaches the point where tools must be ground down excessively to resharpen. That means increased tool life, reduced tooling costs and fewer rejects. Compare the savings on just *one* tool with the cost of this reasonably priced Hagen Count Switch. Chances are, the savings will be much greater.

This Hagen Model 70 Count Switch has 72 dial divisions . . . 72 possible settings. Dials are available with up to 54,000 counts. Accuracy: 1% of full scale range. Ideal for feed pumps and metering operations. Send coupon for Bulletin 780 — or data on the complete line of reset and repeating cycle timers and counters, interrupters and control assemblies.

MAIL COUPON TODAY!

HAGEN
MANUFACTURING COMPANY INC.
Moline, Illinois
Subsidiary of Eagle Signal Corporation

HAGEN MANUFACTURING COMPANY, INC.
Dept. PE-456, Moline, Illinois

☐ Please send free Bulletin 780 on Hagen Count Switch.

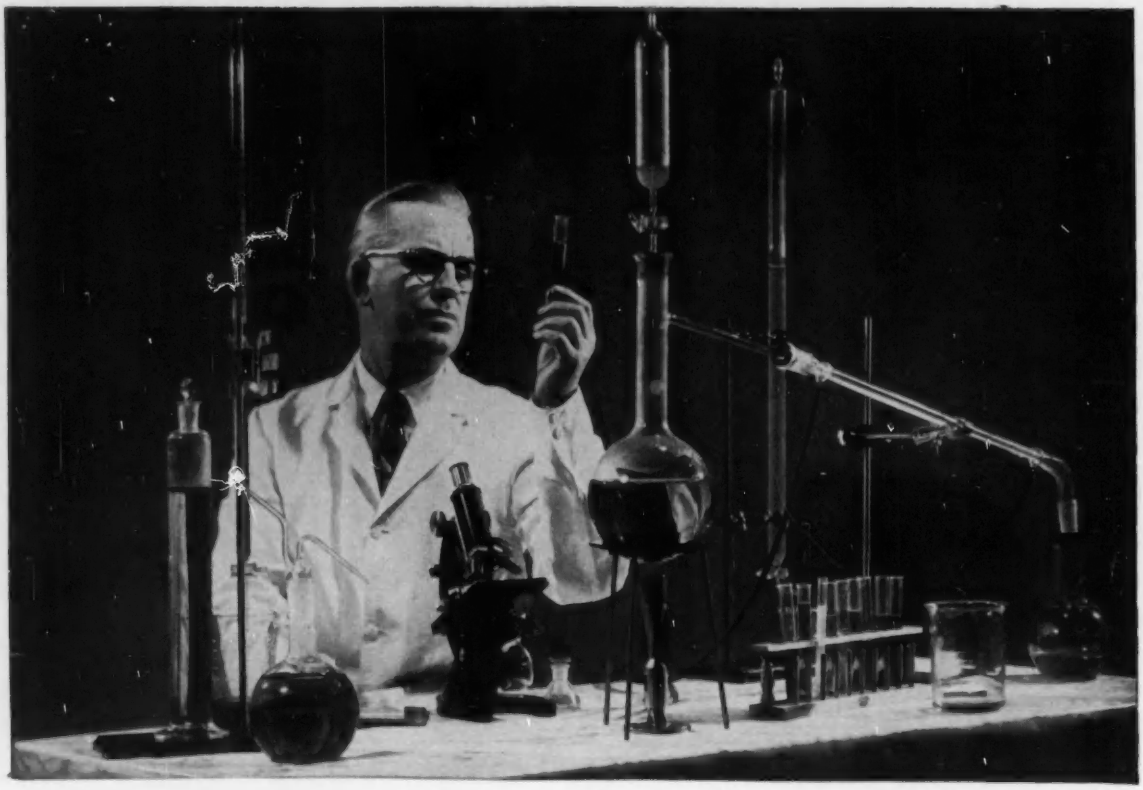
☐ Send free data on counters, timers, interrupters and control assemblies.

NAME AND TITLE

COMPANY

ADDRESS

CITY ZONE STATE



Bonding rubber to nylon is one of PHOENIX' specialties

We are unusually successful at bonding natural and synthetic rubber to nylon. For example, with the flexible coupling shown below, the rubber will actually rupture before bond failure.

When you work with PHOENIX you have twenty years' experience in developmental work at your disposal. Quality control is of the utmost importance at PHOENIX. Modern laboratory facilities and exacting production control methods assure the closest of tolerances.

It is PHOENIX' practice to work in strictest confidence with our customers. Whatever rubber molding problems you may have, call on us. We are here to serve you.

Please address all inquiries to Rubber Products Division.

PUTTING THIS FLEXIBLE RUBBER-NYLON COUPLING THROUGH THE PACES. TESTING ITS "BEND," TENSILE STRENGTH AND TORQUE.

PHOENIX should be your source for custom rubber molding

PHOENIX MANUFACTURING COMPANY

RUBBER PRODUCTS DIVISION — JOLIET, ILLINOIS

New ASCO 3-Way Solenoid Valve assures MILLIONS OF TROUBLE-FREE OPERATIONS

NO EQUAL IN SIMPLICITY!

Simplicity is the secret of this remarkable, new 3-way diaphragm valve. It has *only three operating parts.* Compare this with the larger number of parts found in conventional 3-ways! That's one reason why the new ASCO valve means trouble-free operation . . . substantial savings in maintenance costs . . . reduction in down-time losses.

SIMPLICITY IN OPERATION

Not only its construction but also its new operating principle is the essence of simplicity: solenoid piloting of two simple diaphragms.

UP TO 400 CYCLES PER MINUTE

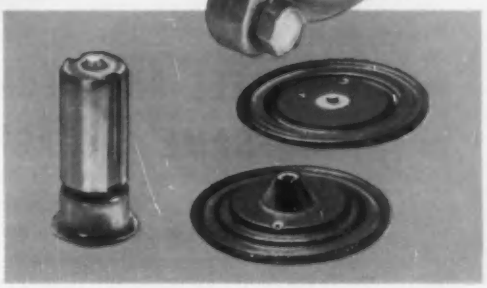
Exceptionally large flow capacity makes rapid recycling feasible . . . cylinders fill and vent rapidly . . . valve operates up to 400 cycles per minute over millions of strokes.

CONVERTS IN 30 SECONDS

Developed for dependable control of liquids and gases, the valve can be converted from normally open to normally closed or the reverse by simple rotation of the valve bonnet.

This new valve is absolutely tight seating . . . no closely fitted parts or valve seat grinding required. Available now in ⅜" and ½" pipe sizes, both with full ⅜" orifices, it can be mounted in any position.

WRITE NOW for your copy of ASCO Bulletin 8316, or have the ASCO Engineer call.



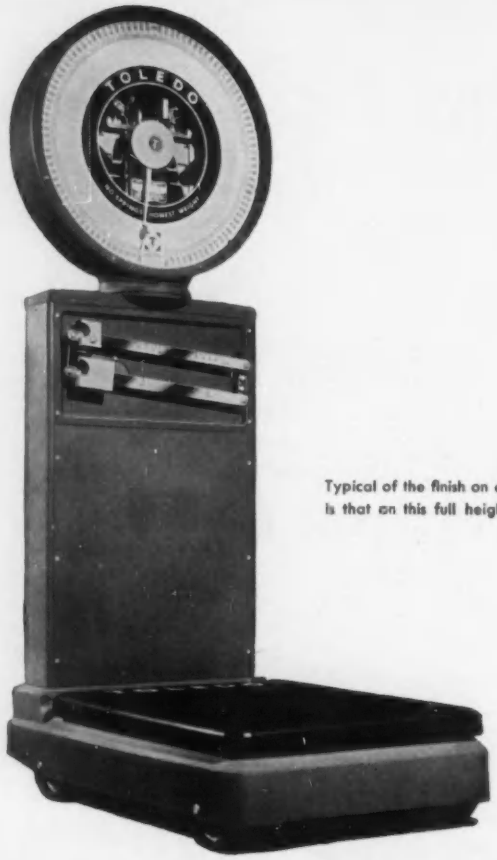
The EXTRA HEAVY FORGED BRASS BODY houses only three moving parts: Two diaphragms and a core. Corrosion protection is assured. All parts in contact with fluids or gases are brass, stainless steel or Buna-N.

ASCO®

DEPENDABLE CONTROL

Automatic Switch Co. • 385 LAKESIDE AVENUE • ORANGE, NEW JERSEY

AUTOMATIC TRANSFER SWITCHES • SOLENOID VALVES • ELECTROMAGNETIC CONTROL



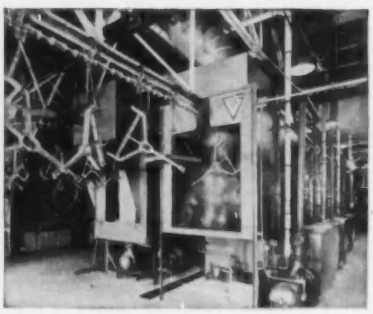
Typical of the finish on all Toledo Scales is that on this full height portable unit.

BOTH STEEL AND ALUMINUM PARTS ARE PROCESSED IN THE SAME 6-STAGE MACHINE AT TOLEDO SCALE

Steel parts are Granodized, aluminum parts are Alodized to inhibit corrosion and provide an excellent base for the high-grade finish used on these familiar products

Toledo Scale knows that the fundamental prerequisite of a good paint job is a properly prepared base material upon which the finish is to be applied. To provide this all-important base, it Granodizes most steel parts with Granodine® and Alodizes most aluminum parts with Alodine.® Granodizing is a chemical process for the treatment of iron and steel which converts metallic surfaces to a nonmetallic coating of the proper texture for inhibiting corrosion and greatly increasing the adhesion and durability of the paint finish. Alodizing performs the same functions on aluminum parts.

Both of these processes are performed in the same 6-stage machine. And both add to the long life of the Toledo finish. Perhaps these ACP processes can be used effectively in your plant. Complete data about both of them are available upon request. Write us.

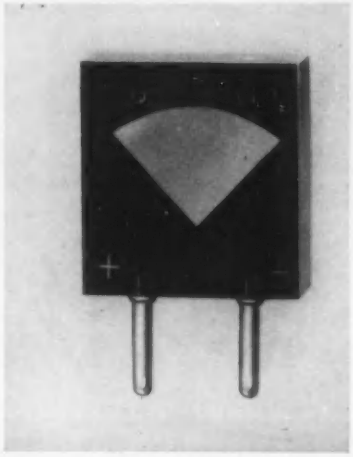


Part of 6-stage machine in Granodizing Department at Toledo Scale Co.

AMERICAN CHEMICAL PAINT COMPANY, Ambler 17, Pa.

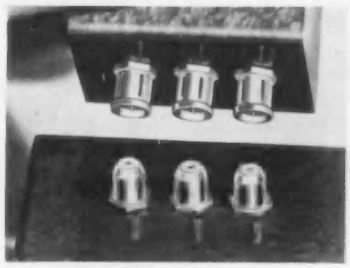
DETROIT, MICHIGAN NILES, CALIFORNIA WINDSOR, ONTARIO

CHEMICALS ACP PROCESSES



at temperatures as high as 150 C, permanent p-n junction and increased power and efficiency. National Products Div., Hoffman Electronics Corp., 2650 W. Belden Ave., Chicago 47, Ill.

For more information—
Circle 47, inside back cover



Miniature Coaxial Connectors

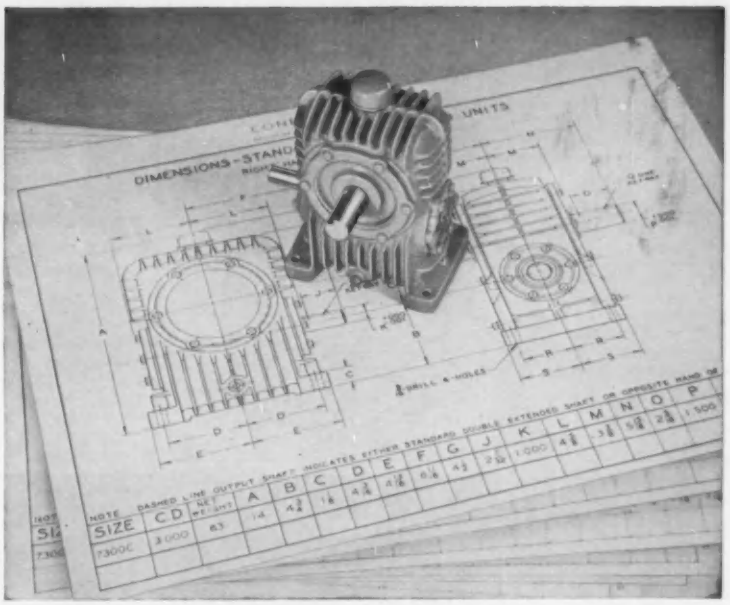
Coaxial connectors are available in 50, 70 and 93-ohm impedances. Microdot, Inc., 1826 Fremont Ave., S. Pasadena, Calif.

For more information—
Circle 48, inside back cover

Two or Three-Position Switches

Mounting is provided by a $\frac{13}{32}$-32 threaded bushing, $\frac{3}{8}$ in. long; a slot in the bushing together with a special washer furnished with the switch provides a non-turn device. This series is also available in two and three-position types, locking or non-locking action. One of these switches can be converted from a non-locking action

(Continued on page 258)



DIMENSIONS ONLY TELL HALF THE STORY...

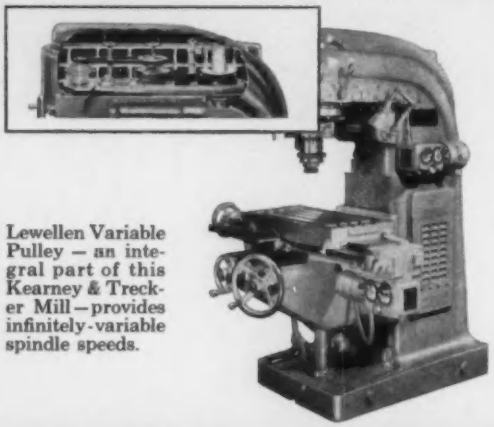
. . . about worm gear speed reducers. You've got to compare size with load capacity for the whole picture. Inside a Cone-Drive speed reducer you'll find the double-enveloping worm gear design that makes it the most efficient right-angle speed reducer available.

Take the standard 3" center distance unit above for example. Here are its Class I Service Ratings with a 5:1 reduction:

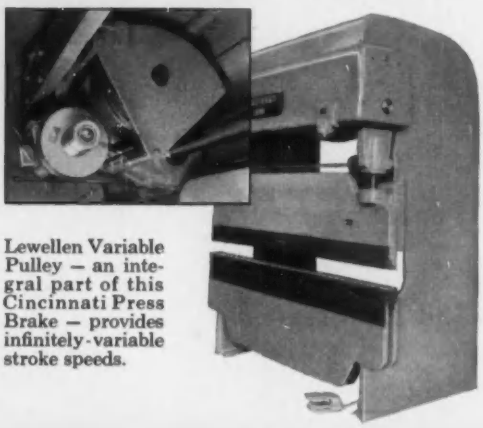
Worm RPM	100	200	300	580	720	870	1150	1750
Mech. HP	1.24	2.21	3.08	4.89	5.61	6.34	7.41	9.04
Thermal HP	1.24	2.21	3.08	4.20	4.62	5.10	6.00	7.80
Output Torque (inch-lbs.)	3340	3010	2830	2405	2250	2150	1940	1575

That's a lot of capacity for a unit that occupies less floor space than this magazine page. But it's typical of Cone-Drive speed reducers and gearsets. Complete details on this model in Bulletin 600-C. Other units to 800 HP and ratios to 4900:1.

CONE-DRIVE GEARS
Division, Michigan Tool Company
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
7171 E. McNichols Road • Detroit 12, Michigan



Lewellen Variable Pulley — an integral part of this Kearney & Trecker Mill — provides infinitely-variable spindle speeds.



Lewellen Variable Pulley — an integral part of this Cincinnati Press Brake — provides infinitely-variable stroke speeds.

Coordinate machine, man, job — with

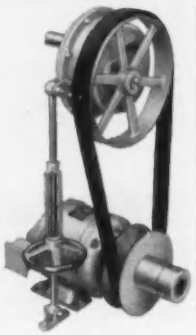
LEWELLEN VARIABLE PULLEYS

CRAMPED FOR SPACE?

Mount Variable Pulley at the machine shaft. Small motor sheave, short Variable Belt compacts the drive. Lewellen Variable Pulley adapts to any arrangement the resourceful engineer may plan.

NEED SLOW MACHINE SPEEDS?

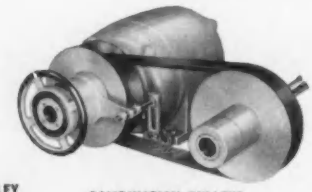
Drive to shaft-mounted reducer. Turnbuckle adjusts centers — and speeds — motor base is eliminated. Lewellen Variable Pulley and other standard components equip the power package... compact — economical — accessible.



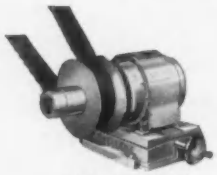
Lewellen Variable Pulleys and accessories are versatile power components that perform smoothly and dependably — installed in any position and operated in any manner. Drive to sheave (Kearney & Trecker Mill) or flywheel-clutch (Cincinnati Press Brake) as well as pulley, flat or crown face. Selection of ratings, speeds, centers permits widest latitude for incorporating variable speeds. 300 Series Lewellen Variable Pulleys scale to new N. E. M. A. motor frames, also fit old frames. 300 Series offer 40% space savings, 50% overhung load reduction.

Write for Variable Pulley Catalog No. 60 ... Transmission Catalog No. 65

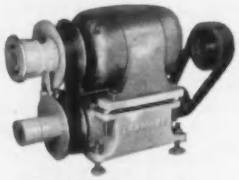
VARIABLE PULLEY WITH COUNTERSHAFT



COMBINATION PULLEYS



VARIABLE PULLEY



COMBINATION PULLEYS WITH COUNTERSHAFT

LEWELLEN MANUFACTURING CO., COLUMBUS, IND.

DISTRIBUTORS IN ALL INDUSTRIAL AREAS • IN CANADA — PEERLESS ENGINEERING SALES LTD., TORONTO — MONTREAL

ANOTHER NEW HOUGHTON DEVELOPMENT IN PACKING DESIGN

HOMOGENEOUS RUBBER | FABRICATED RUBBER | LEATHER

STANDARD STACK HEIGHT

for "V" Packings

Good news for the designer! This new packing development standardizes the stack height of *all* Houghton "V" packings. Simply determine the number of packings needed in the gland (according to your pressure requirements) . . . then allow for the specified dimension in your drawing. Whether you use homogeneous rubber, fabricated rubber or leather "V's" . . . they'll fit!

You can forget "special" dimensions set up by various packing manufacturers for particular types of packings. Standardize on stack height with packings from Houghton and you'll save time and money from the drawing board on!

The leadership in hydraulic know-how is typical of Houghton, which supplies all types of hydraulic and pneumatic packings, as well as a complete line of hydraulic oils and fluids.

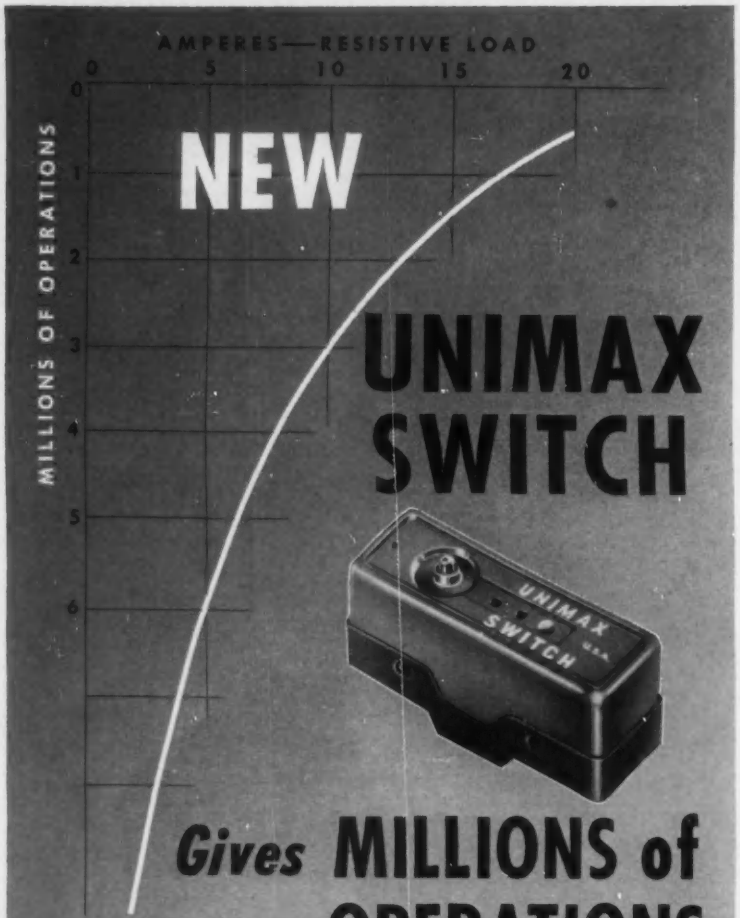
Standardize on Houghton. You'll get the newest first—and the best always. Call your Houghton Man and let him explain Houghton's Hydraulic Service. E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa.

. . . product of

E F HOUGHTON & CO.

PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

Ready to give you on-the-job service . . .

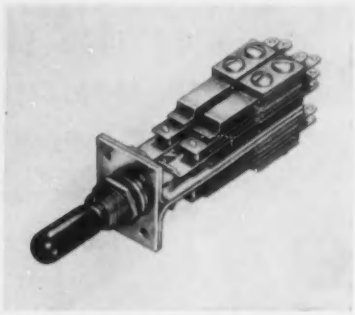


To meet accelerated demands for Unimax precision switches, we now occupy a new modern plant, fully air-conditioned, with filtered and electrostatically cleaned air precisely controlled as to temperature and humidity. Enlarged new manufacturing and laboratory facilities enable us to maintain even higher standards of performance.

Series HB 20-ampere Miniature Snap-acting Switch

- **HEAVY DUTY . . .**
  20 amp. 125/250/480 v.
  a-c ratings 1½ horsepower 250 volts
  ¾ horsepower 125 volts
  d-c ratings 0.50 amperes 125 volts
  0.25 amperes 250 volts
- **REPEAT ACCURACY . . .**
  Consistent throughout switch life.
- **WIDE VARIETY . . .**
  of standard overtravel plungers and leaf actuators; special actuators can be furnished to your requirements.
- **FREE CATALOG . . .**
  gives details of entire Unimax Switch line. Write for your copy.

UNIMAX SWITCH
Division The W. L. Maxson Corporation
IVES ROAD, WALLINGFORD, CONNECTICUT



to a locking action by removing a simple stamping supported by two screws. Contacts are welded cross bar, palladium standard. Switchcraft, Inc., 1328 N. Halsted St., Chicago 22, Ill.

For more information—
Circle 49, inside back cover

Subminiature Snap Switches

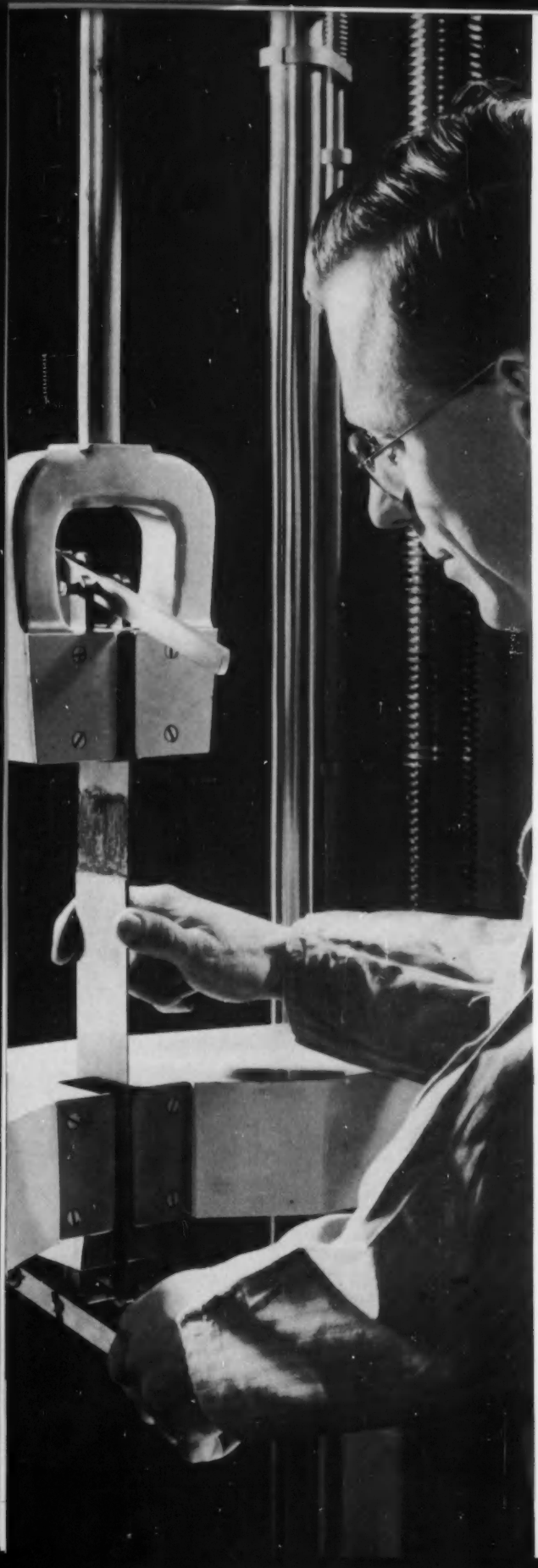
These dry, gas-filled, hermetically sealed, single-pole, double-throw units are rated at 5 amp resistive, 3 amp inductive, 2 amp motor load, either 28 v, dc, or 110 v, ac. Electrical and mechanical life is said to be 100,000 cycles. The series is available with either bracket or through-hole mounting plus potted lead wires good for 250 F. Haydon Switch, Inc., 536 S. Leonard St., Waterbury 20, Conn.

For more information—
Circle 50, inside back cover

Medium-Carbon Die Steel

This steel is especially designed to provide a steel for molds and cavities where high surface finishes are desired. It can be uniformly deep hardened at hardness ranges from 300 to 350 Bhn throughout sections as large as 20 x 10

(Continued on page 265)

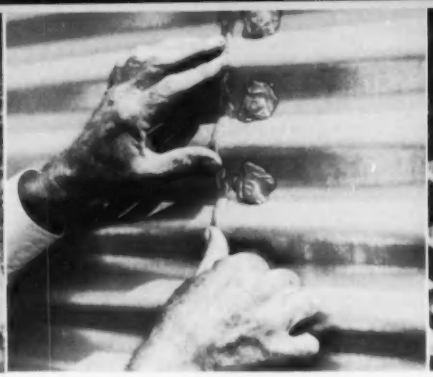


Only one material on earth

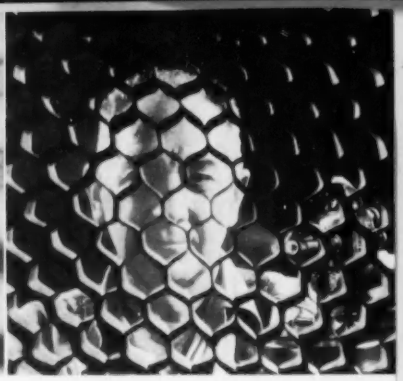
can improve the design of your product in each of the following 24 uniquely valuable ways! It's an adhesive material—like the modern, scientific adhesives, coatings and sealers developed by the research laboratories of 3M.

3M COMPANY

1 **Distribute Fastening Load** over the entire joint area. By giving continuous contact between mating surfaces, 3M adhesives minimize local stress concentrations. For instance, EC-404 is sprayed on this fibrous glass acoustical pad. Immediately it holds the pad in place under the automobile roof without sagging.

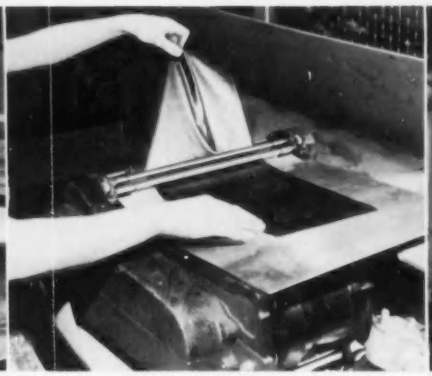


2 **Resist Fracturing** because of residual elasticity. Instead of separating, chipping or flaking, 3M adhesives absorb some of the stresses created by flexing, vibration and differing coefficients of expansion. Thus EC-612 provides a flexible, permanent, weather-proof non-shrinking seal for sheet metal structures.



3 **Reduce Weight** because 3M adhesives usually are lighter than the mechanical fasteners they replace. Also they allow use of lighter-gauge materials. Without adhesives like EC-1177 to bond components, the lightness and strength of today's honeycomb sandwich construction would be literally impossible.

10 **Meet Varied Needs** of manufacturing processes. 3M adhesives have different tack and curing characteristics, can absorb oil, withstand paint operations or reactivate to suit your needs. Immediately after spraying, this 3M adhesive holds waffle felt so strongly that the truck cab top can be handled without delay.

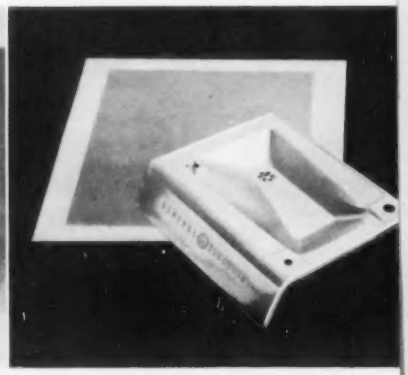


11 **Apply Many Ways** to allow you greatest manufacturing efficiency. This plastic-coated cloth is roll-coated with EC-880 before being die-cut and bonded to phenolic resin. Other 3M adhesive application methods include: brushing, spraying, flowing, dip and knife coating, scraping, troweling and thumbing.

12 **Fasten While Resisting** heat, water and chemicals. EC-404 bonds sound damping pads inside the doors of these metal sink cabinets despite the following phosphatizing process: 1) strong detergent pressure spray, 2) wash, 3) phosphating spray, 4) two rinses, 5) drying oven temperatures reaching 500° F.

16 **Protect Against Erosion** by fast-flying particles. Rain or dust, for instance, can damage the aircraft that meets them at the speed of sound. So manufacturers apply a lightweight, long-lasting 3M coating. Because the coating has rubberized plastic base, it is not only tough, but flexible.

17 **Damp Vibration** and sound in a single, quick, economical operation. Here, 3M Coating EC-1000 is sprayed on movable metal wall panels. Immediately the backs of the panels are primed and baked without damage to the coating. Installed, the panels make rooms that are quieter, less affected by vibration.



18 **Protect During Assembly** and manufacturing. Sheet metal is coated with oil-resistant EC-968 before being formed into this water cooler top plate. During seven die operations, the coating stretches with the metal, shields it from die marks. Then it is easily stripped off in a continuous film by hand.

See what adhesives are doing today!

PHOTO COURTESY OF CONSOLIDATED VULTEE AIRCRAFT CORPORATION

Materials that perform better on the assembly line and in the finished product, too, make possible design advances in mass production industries. Aircraft makers are building better planes for less with 3M adhesives.

From aircraft to air conditioning— 3M adhesives are the sign of advanced design

Do you know the amazing things scientific 3M adhesives are doing for today's product design? They are bringing design improvements to almost every metalworking industry. Designs utilizing 3M adhesive products are paying off sales-wise and cost-wise with: simpler shapes, smoother surfaces, greater strength and durability, less need for close tolerances, fewer parts and production operations. In many cases, these design improvements would be impossible without modern adhesives.

Air conditioning is one of many custom fabrication and installation fields in which 3M adhesives offer fast, easy application, plus dependability.

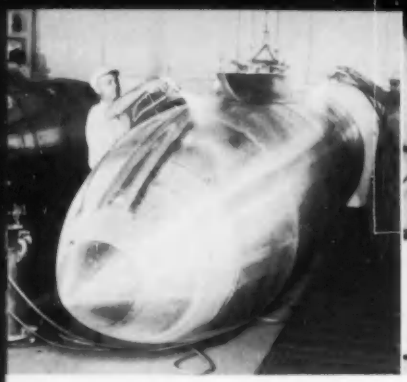


PHOTO COURTESY OF MUSKEGON PISTON RING CO.

4 Allow Smoother Contours by filling gaps and voids, replacing mechanical fastenings, or covering bolts and rivets. Thus adhesives can improve product safety, beauty and performance. By smoothing out surface variations, for example, 3M coatings improve the aerodynamic qualities of aircraft.

5 Allow Complex Shapes to be fabricated, which might be impossible with conventional fasteners. Oil rings, "unitized" with a 3M adhesive, don't separate during handling, despite extreme expansion or distortion. Yet, in a running motor, the adhesive dissolves to let the rings perform unhindered.

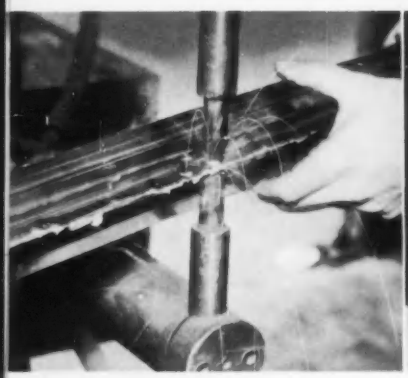
6 Speed Assembly by reducing the number of operations. With EC-847, this one man daily installs fiberboard covers in more than 1000 air conditioner compressor housings. The previous method involved a weld, a nut, a screw and a steel cover. Now, the 3M adhesive cuts assembly costs, allows fewer parts.

IN ALL THESE 24 WAYS

3M ADHESIVES

3M adhesives, coatings and sealers cut metalworking costs, add to product quality!

3M adhesives, coatings and sealers are as versatile as metal itself. Only a few of their known uses are shown on these pages. And every day they're improving product performance and cutting costs in new, unexpected ways. Each 3M adhesive is tailored to fit specific job requirements. Yet often the same adhesive can perform many different jobs. In fact no other type of material can do all the varied things that 3M adhesives do so well, so inconspicuously, so economically. Examine the 24 abilities of 3M adhesives, coatings and sealers illustrated on these pages. Consider what 3M adhesives can do for you.



19 Seal Welded Seams tighter against weather and water by allowing the welds to be made right through the sealer. During spot-welding, EC-1168 neither splatters nor burns. And as it squeezes away from the immediate weld area, it fills in tightly all around to form a permanent seal.

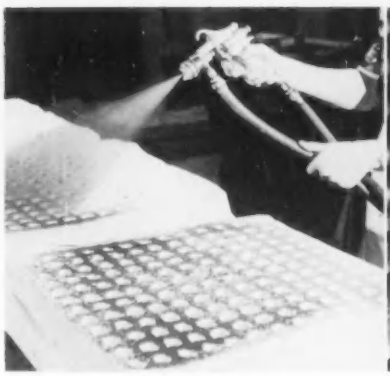
20 Seal Air, gas and fumes in or out at seams and joints. EC-750, for example, seals the joints of air conditioning ducts. Thus, this 3M sealer prevents air escape, insures top efficiency. Neither heat nor cold affects this sure, permanent seal. Other 3M products seal pressurized aircraft cabins.

21 Seal With Ribbon sealers that give flexible, weather-tight seals between mechanically held surfaces. In the trailer industry, and many others, EC-1202 applies with exceptional ease to seal sheet metal lap seams and joints. Workers press EC-1202 on one surface, fasten down the mating surface.

7 **Protect By Fastening** with a continuous adhesive film which resists corrosion. This film keeps corrosive moisture, gases, dust and fluids from entering between mated surfaces and into interior voids. Thus 3M Adhesive EC-1233 both anchors this rubber floor mat and also increases durability of the bus floor.

8 **Apply More Rapidly** than most fastening devices. No drilling, aligning or rivet bucking is needed. A quickly sprayed layer of EC-776 will bond these aluminum plates to anodized aluminum cores for camera film holders. The 3M adhesive was selected as more economical, easier and less conspicuous than spot-welding.

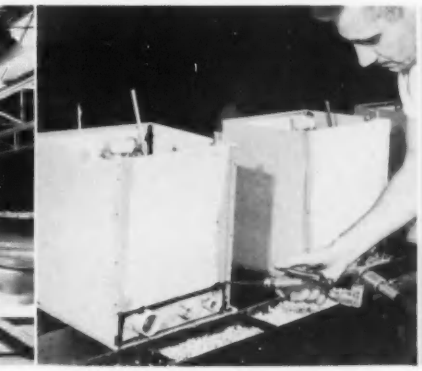
9 **Apply More Easily** with unskilled labor. Workers can apply most 3M adhesive products with little or no training, yet gain dependable results. This man brushes EC-321 on the chemically etched metal interior of an incinerator cabinet. The nonflammable adhesive will hold fibrous glass insulation.

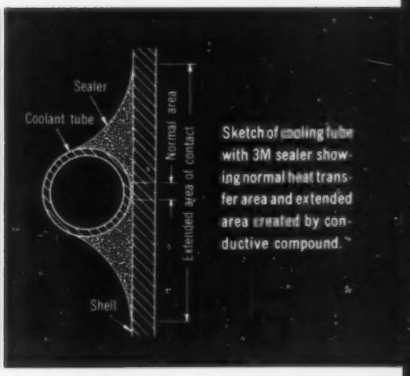


13 **Join Varied Materials** of the most diverse sorts to themselves and to one another: metal, rubber, wood, plastic, linoleum, felt, wallboard, ceramics, paper, glass insulation. A manufacturer makes these bus seats without tacks by bonding fabrics, sponge rubber, metal, leather, vinyl and carpeting with EC-164.

14 **Protect Against Abrasion** with tough, resilient coatings. This worker sprays abrasion- and corrosion-resistant EC-1141 on coil springs for railroad cars. Though grease collects on the springs later and may ignite, the coating will not burn off. Other 3M coatings form walkways and anti-glare surfaces.

15 **Protect Against Corrosion** and rust by shielding metal surfaces with moisture-proof, waterproof coatings. Various 3M coatings also resist detergents, oils and fumes. The life expectancy of this railroad car is being increased by priming the sub-floor with EC-524, then coating it with EC-831.





Sketch of cooling tube with 3M sealer showing normal heat transfer area and extended area created by conductive compound.

22 **Seal Seams** and joints to shut out moisture, water, dust and detergents, and thus prevent corrosion. EC-895, a rubber-based 3M sealer, bars moisture from all openings in the "low-side assembly" box of this water cooler. It also completely seals the housing, keeps moisture out of granulated cork insulation.

23 **Swell To Seal** even irregular voids and gaps. EC-1055 is applied quickly by hand in extruded bead form, left. During heat curing, it expands by as much as 100 per cent or more, right. Entirely solid, EC-1055 forms a positive, uniform gasket-like seal that holds out water, dust and dirt.

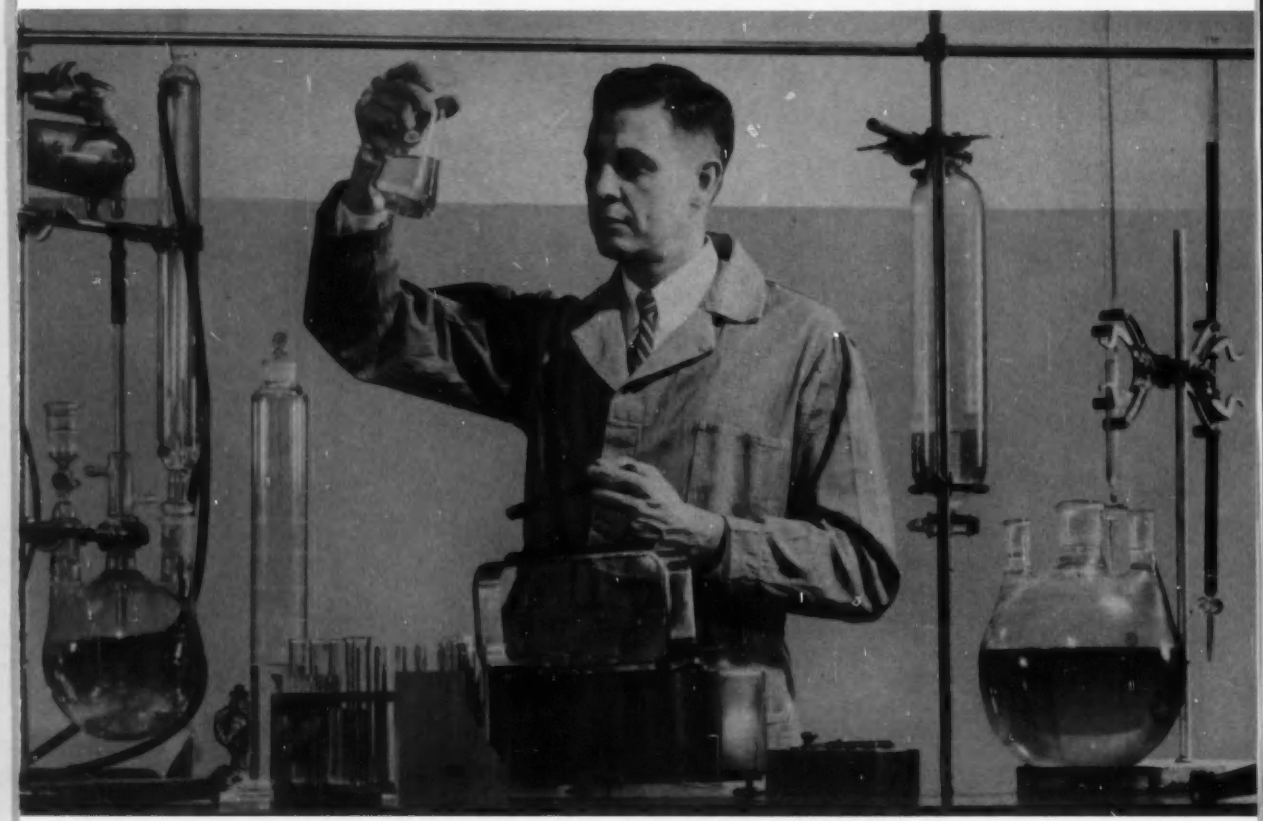
24 **Conduct Heat** to increase the efficiency of refrigerating units. Manufacturers flow a heat conductive 3M sealer between the coils and shells of home freezers. The diagram above shows how the sealer increases contact area, thus accelerates the rate of heat transfer. The consumer gains lower operating costs.

3M BRAND

In product, in production

3M RESEARCH CAN MEAN PROGRESS THROUGH ADHESIVES FOR YOU

If you fabricate a metal product, chances are a 3M adhesive, coating or sealer can both improve it and cut your costs. You owe it to your product to find out. Use the coupon below. Write 3M for full facts now. 3M research is your assurance both of uniform high quality and of painstaking formulation to fit your job. Whether you face a specific problem or a general need, consult: Minnesota Mining and Manufacturing Company, Adhesives and Coatings Division, Dept. F-1, 417 Piquette Ave., Detroit 2, Mich. Quality adhesives may be the answer.



FIND OUT WHAT ADHESIVES CAN DO FOR YOU—WRITE FOR FULL INFORMATION

Minnesota Mining and Manufacturing Company
Adhesives and Coatings Division,
Department F-1, 417 Piquette Avenue,
Detroit 2, Michigan

Sirs:

Please send me detailed information on the newest uses of 3M adhesives, coatings and sealers in the following industry(ies):

☐ Automotive ☐ Railroad ☐ Buses and Trucks
☐ Aircraft ☐ Insulation ☐ Trailers
☐ Refrigeration and Air Conditioning ☐ Sheet Metal ☐ Other (.....)

In addition, I would like further information on the applications of 3M products illustrated by the pictures in this advertisement bearing the following numbers:

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

MY NAME _____

TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____

ADHESIVES AND COATINGS DIVISION • **MINNESOTA MINING AND MANUFACTURING COMPANY**

417 PIQUETTE AVE., DETROIT 2, MICH. • GENERAL SALES OFFICES: ST. PAUL 6, MINN. • EXPORT: 99 PARK AVE., N. Y. 16, N. Y. • CANADA: P. O. BOX 757, LONDON, ONT.

MAKERS OF **"SCOTCH"** BRAND PRESSURE-SENSITIVE TAPES • **"SCOTCH"** BRAND SOUND-RECORDING TAPE • **"SCOTCHLITE"** BRAND REFLECTIVE SHEETINGS • **"3M"** ABRASIVE PAPER AND CLOTH • **"3M"** ADHESIVES AND COATINGS • **"3M"** ROOFING GRANULES • **"3M"** CHEMICALS

in. High surface hardnesses are obtained by carburizing and then oil quenching. The new steel is generally sold in large rounds or blocks. Vanadium-Alloys Steel Co., Latrobe, Pa.

For more information—
Circle 51, inside back cover

Elastomeric Adhesive

An elastomeric adhesive for contact and hot bonding a wide variety of porous and non-porous surfaces can be used in bonding metal frames to veneered ply-wood, aluminum sheets to aluminum channels and decorative plastic laminates to metal counter and table tops. It can also be utilized as an adhesive for sandwich construction, in which aluminum sheets are bonded to impregnated kraft paper honeycomb. The adhesive is grey-green in color. It has a thin syrup consistency and weighs about 7 lb per gal. Heat resistance of the material is up to 160 F. Minnesota Mining & Mfg. Co., 411 Piquette Ave., Detroit 2, Mich.

For more information—
Circle 52, inside back cover

Metal Bonding Adhesive

A structural metal bonding adhesive is reported to be able to bond aluminum, steel, zinc, copper, brass, iron, glass, wood, rubber and plastic surfaces to themselves and to each other permanently. The adhesive is reportedly suitable for manufacturing, assembling, laminating and repairing where high strength, permanent, structural bonds are required. H. B. Fuller Co., 181 W. Kellogg Blvd., St. Paul, Minn.

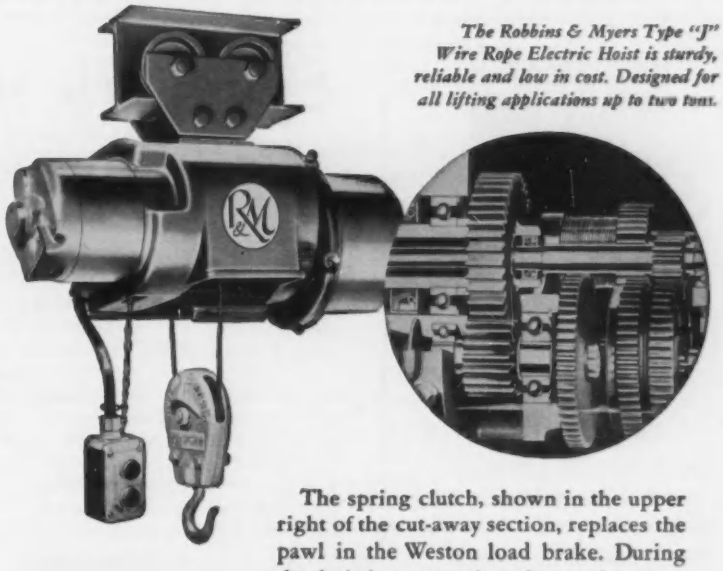
For more information—
Circle 53, inside back cover

Flexible Seamless Aluminum Tubing

Lengths can be supplied up to 10 ft. Depending upon internal pressure and operating conditions, this flexible tubing is furnished in open or closed pitch helical convolutions, with or without metallic braid jacket. Standard pipe thread fittings of the flare type are applied without solder, braze, or packing. The tubing is now avail-

(Continued on page 268)

Marquette SPRING CLUTCHES
assure dependable operation in Robbins & Myers Electric Hoists



The Robbins & Myers Type "J" Wire Rope Electric Hoist is sturdy, reliable and low in cost. Designed for all lifting applications up to two tons.

The spring clutch, shown in the upper right of the cut-away section, replaces the pawl in the Weston load brake. During the hoisting operation the ratchet must turn, but during the lowering operation it must be held stationary. The spring clutch is attached to the ratchet by gear teeth, thus providing a continuous connection and instant holding as soon as lowering is started.

The Hoist & Crane Division of Robbins & Myers, Inc. states that "the Marquette Spring Clutch provides these desirable features in a compact, dependable and simple unit".

There's a Marquette Spring Clutch for almost every purpose—over-running or free-wheeling... indexing... reversing... single revolution... delayed action... and bi-directional no-back brakes. They are low cost, compact and trouble-free.

There are no restrictions on torque. Actual designs range from 6 in. lbs. to 25,000 ft. lbs. Speeds? From 1 to 10,000 r.p.m.

The Marquette
METAL PRODUCTS CO.
SUBSIDIARY OF CURTISS-WRIGHT CORPORATION
ALSO MANUFACTURERS OF: ROLLER BEARING TEXTILE SPINDLES
HYDRAULIC GOVERNORS • PRECISION PARTS AND ASSEMBLIES
AIRCRAFT WINDSHIELD WIPERS • FUEL OIL PUMPS & INJECTORS
ROTARY HIGH PRESSURE OIL FIELD PUMPING MACHINERY

A PRODUCT OF CW CURTISS-WRIGHT

THE MARQUETTE METAL PRODUCTS CO.
1143 Galewood Drive, Cleveland 10, Ohio

Please send manual describing the functions, applications and operations of the basic types of Spring Clutches.

COMPANY_____

NAME_____ TITLE_____

ADDRESS_____

R B & W FASTENER BRIEFS

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

Technical-ities

By John S. Davey

Coarse Threads Better Than Fine For Many Jobs

The load and stress concentrations on threads are lower in standard coarse thread fasteners than in fine threaded ones. Flank engagement is also greater because coarse threads are deeper. Except in such cases where fine adjustments are needed, coarse threads are, therefore, preferable to fine threads. They have greater resistance to stripping and, consequently, can be more highly torqued to make a stronger assembly.

PRODUCTION SAVINGS

Coarse thread fasteners tighten with only two-thirds the revolutions needed for fine threads. So your assembly time is faster, too. Coarse thread bolts enter nuts or mating holes with less tendency to cross thread when not truly positioned. In hard-to-reach areas, this ease of starting can often be your deciding factor. Bear in mind, too, that coarse threads need less "babying" in handling since they're less apt to be damaged.

All in all, coarse threaded standard fasteners prove best for an assembly because of their additional clamping strength—and best for the assembler because of their extra economy and production advantages.

Spin-Lock screws increase holding power by 20%

EXPERIENCE confirms that Spin-Lock screws hold tight under conditions of vibration or repeated heating and cooling. Their strong teeth have a ratchet action on the bearing surface—the acute angle lets the screw tighten fast and easily, until the teeth actually embed into the seat upon tightening, as shown in the sectional photomacrograph below. The almost vertical face of the teeth then resists counter-rotation and loosening. As a result, it takes about 20% more torque to loosen a Spin-Lock than to tighten it.

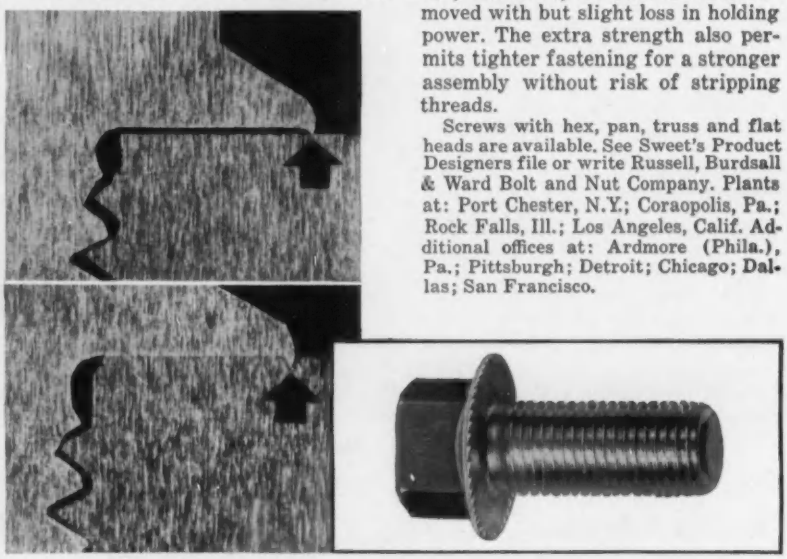
LOWER COST ASSEMBLY

Spin-Lock screws avoid need for washers or external locking devices. One-piece construction, they allow faster assembly and can be easily handled and driven in cramped spaces.

STRONGER ASSEMBLY

Heat treatment gives the teeth hardness and toughness. Spin-Lock screws can, therefore, be reused when removed with but slight loss in holding power. The extra strength also permits tighter fastening for a stronger assembly without risk of stripping threads.

Screws with hex, pan, truss and flat heads are available. See Sweet's Product Designers file or write Russell, Burdsall & Ward Bolt and Nut Company. Plants at: Port Chester, N.Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.



High strength bolts improved product at a saving

A mechanical vibrating shaker naturally suffers severe abuse itself from vibration. One manufacturer of such machines used costly special fasteners and lock nuts to control tendency of the product to loosen up.

Asked about it, RB&W recommended a standard high strength bolt, heavy nut, and two hardened washers. These permitted a high tensile clamping force to be developed. Residual tension was ample for the most severe operating conditions and kept the bolts tight. Result: A 25% saving in annual fastener cost, the constant availability of standard items, and less maintenance for the product. You too can draw on RB&W experience for technical help to assure a strong assembly and to cut costs.

Mash Resistance Welding

Its use to achieve product improvement and fabrication economy

What is Mash Welding?

Mash welding is a type of resistance welding used to join the edges of two sheets of metal and produce a flush surface of the near original thickness of one sheet. After completion of the weld, both sheets lie on the same plane. The welded area, minutely thicker, requires only a minimum of finishing.

No gas, flux, or rod is required. Parts to be joined are simply placed between the welding electrodes . . . pressure is applied . . . a flow of current is passed through the piece parts via the electrodes. Natural resistance of the metal parts to the electrical flow creates a heat that causes the metals to fuse at the point of electrode contact.

To demonstrate: Fig. 1 shows the edges of two metal sheets that are to be joined over lapping, approximately the thickness of one sheet of the material. Fig. 2 shows flat faced wheel type electrodes being passed over the lapped edges. The welding current passes either continuously or in a series of closely spaced impulses.

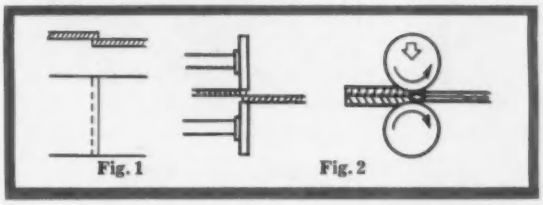


Fig. 1 Fig. 2

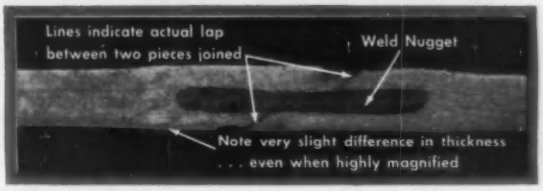

Lines indicate actual lap between two pieces joined
Weld Nugget
Note very slight difference in thickness . . . even when highly magnified

Fig. 3. Macrograph of typical mash weld.

When to Design for Mash Welding

Specify Sciaky "Mash Resistance Welding" whenever you wish a flush joint without a weld bead, rivet heads, or exterior fastening of any kind. Typical applications are tanks and conical shapes where a minimum of exterior finishing is desired. An enlargement of a welded cross-section of a typical piece part application is illustrated in Fig. 3 . . . a strong, yet smooth, metal marriage.

Advantages of Resistance Welding

Production increase and lower operating costs are direct results of the application of Sciaky resistance welding techniques. The simplicity and effectiveness of the Sciaky technique reduces multi-step fastening operations to just one. No skilled workers are required . . . one operator can consistently produce welds suitable to both quality and production requirements.

Sciaky Patented Three-Phase Resistance Welders

Invented, pioneered, and patented by Sciaky, the Three-Phase principle of resistance welding allows a balanced current to be drawn from all three phases of the power supply. The three-phase balanced load, high power factor principle of operation offers direct savings in lower power bills, lower installation costs, smaller distribution lines, and smaller switch gear.

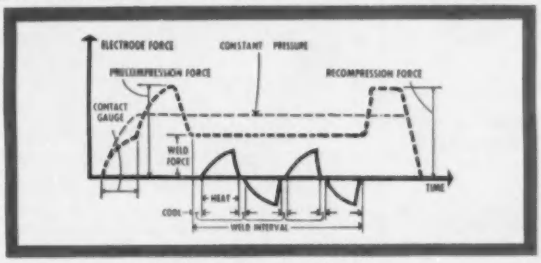


Fig. 4. Three-Phase Weld Sequence.

Sciaky Plans for Tomorrow . . . at their New Research Center

Sciaky's new three-quarter million dollar Research Center is equipped with the most advanced resistance welding machines, testing instruments, and trained personnel devoted to solving *your* joining problems and advancing the application and development of resistance welding. The Research Center invites *you* to submit your fastening design problems.

Build Your Data File with FREE Sciaky Literature

Write today on your company letterhead describing your particular field of interest. We will send suitable back issues (as well as future issues) of our "Resistance Welding At Work" publication, showing typical design problems solved by this method of fastening. All contain impressive case history examples of Sciaky basic thinking—resistance welding techniques designed to do more *useful work* at *lower operating costs with maximum reliability.*

Largest Manufacturers of Resistance Welding Machines in the World

SCIAKY®

Sciaky Bros., Inc., 4913 West 67th Street, Chicago 38, Ill., Portsmouth 7-5600

NORGREN
AIR PRESSURE REGULATORS

Accurate, Dependable Control of Air Pressure

There's a Norgren Regulator for Every Air Regulation Need.

All air-operated equipment is designed to operate most efficiently at one specified air pressure. Pressures in excess of this specified pressure result in greater wear, more down-time, higher maintenance cost and waste of air. You can select a Norgren Regulator that will provide the desired pressure at all times, holding it constant even though the line pressure or rate of flow may vary.

How Norgren Regulators Provide Accurate, Trouble-Free Service...

1. PRECISION CONSTRUCTION

Norgren Pressure Regulators are precision built throughout to provide accurate pressure regulation under the most rugged conditions.

2. PRESSURE KEPT CONSTANT

Norgren Pressure Regulators respond quickly to sudden demands for greater air volume without an excessive momentary pressure drop.

3. EFFICIENT OPERATION

A baffle plate and siphon tube permits greater air flow with less pressure drop and protects the diaphragm against sudden pressure surges and chatter.

4. LONG-WEARING DIAPHRAGM

The diaphragm in Norgren Pressure Regulators is made of oil-resistant synthetic rubber reinforced with nylon fabric.

5. RELIEVING FEATURE

The built-in relieving feature available on all models safeguards connected equipment against damage through pressure surges—permits downward adjustment of pressure without auxiliary "bleeding" of line.

6. EASY TO INSTALL

Pipe connections are straight through for easy installation. In addition, most models can be completely dismantled without removing them from the air line.

Without obligation, learn how Norgren Pressure Regulators can reduce costs in your plant. Call your nearby Norgren Representative listed in your telephone directory, or **WRITE THE FACTORY FOR NEW NO. 700 CATALOG.**

C.A. Norgren CO.

3428 So. Elati St., Englewood, Colo.

Wherever Air is Used in Industry

NEARLY 400 STANDARD MODELS

NORGREN AIR PRESSURE REGULATORS, RELIEVING

Relieving feature provides added protection against excessive pressure build-up. Permits downward adjustment of pressure without "bleeding" of line. Maximum allowable primary pressure is 450 psi; adjustable delivery pressure is 2 to 250 psi. Pipe sizes—¼" to 1" inclusive. Series 2AX.

NORGREN AIR PRESSURE REGULATORS, STANDARD

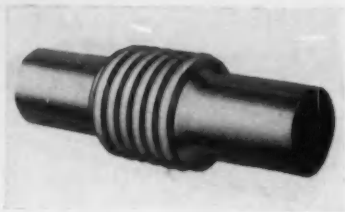
Maximum allowable primary pressure is 450 psi; adjustable delivery pressure is 2 to 250 psi. Pipe sizes—¼" to 1" inclusive. Series 2A.

NORGREN AIR PRESSURE REGULATORS, PRECISION

For precise control of air pressure in the range of 0 to 2 cfm. Specially suited for use with air-controlled instruments. Maximum allowable primary pressure is 400 psi; adjustable delivery pressure is 1 to 30 psi. Relieving type. Pipe size—¼". Series 11,400.

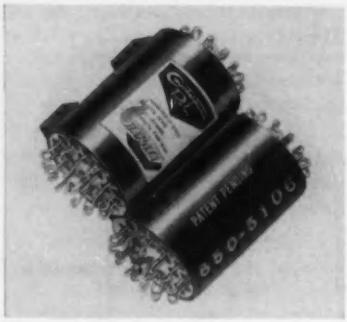
NORGREN AIR PRESSURE REGULATORS, PILOT-CONTROLLED

A precisely controlled air cushion provides an extended adjustable range, more accurate pressure regulation, increased capacity in cfm. Maximum allowable primary pressure is 400 psi; adjustable delivery pressure is 2 to 120 psi. Pipe sizes—½", ¾", 1". Series 20AA.



able from ¼ to 2 in. ID inclusive. Scamlex Co., Inc., 4123 24 St., Long Island City 1, N. Y.

For more information—
Circle 54, inside back cover



Counterpoise Relay

Available models include a tandem-type, 24-pole, double-throw model, a 12-pole design, a relay for 400 cps input. Cook Electric Co., 2700 Southport Ave., Chicago, Ill.

For more information—
Circle 55, inside back cover

Hydraulic Hose Fitting

This fitting consists of socket and nipple. It does not require the hose cover to be stripped off. Make-up is accomplished in two simple steps: (1) the hose is rotated into the socket counter-clockwise; and (2) the nipple is screwed clockwise into the hose and socket.

The lead thread of the socket, acting like the colter wheel on a plow, cuts through the rubber cover of the hose permitting the following threads to contact the wire braid. This engagement forms a grip that is said to hold beyond hose-bursting pressures as well as under severe vibration conditions. The rubber of the hose cover is compressed between the threads of the socket and acts as a vibration-

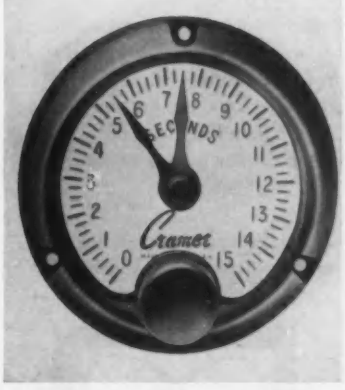
(Continued on page 269)

damper, adding life to the holding power and stress-resistance of the hose right at the joint where flexing can lead to hose failure, especially in connections where the hose cover has been removed.

Four different connecting ends are offered: (1) tapered male pipe thread; (2) new straight thread with O-ring sealing; (3) JIC standard 37 deg flare nose for tube connection; (4) swivel nut for connection with any of this manufacturer's adapters.

Machined from steel bar stock, first sizes available are for hose of $\frac{1}{4}$, $\frac{3}{8}$ and $\frac{1}{2}$ in. ID. Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

For more information—
Circle 56, inside back cover



Two Time Delay Relays

Both of these instruments are reported to be capable of maintaining repeat accuracy within ± 0.25 per cent of full scale (30 sec and longer ranges),

(Continued on page 272)

Now...

Norgren MICRO-FOG Lubricators

for 32, 200, 300 and 1000 BEARING INCH REQUIREMENTS

For Lubricating

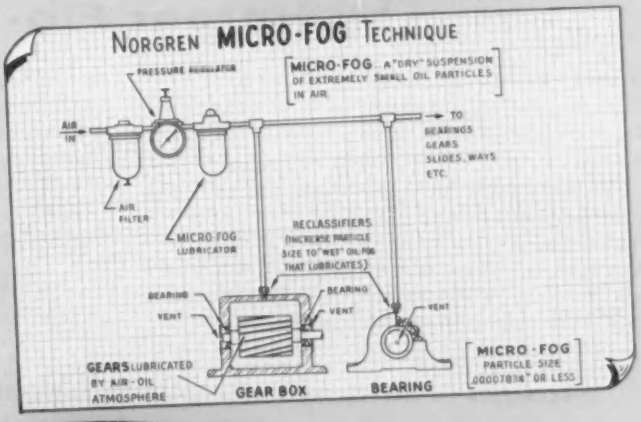
Bearings • Gears • Chain Drives • Cams • Ways • Slides • Other Machine Components

Model S3406-8S
1 quart oil capacity
300 bearing inch capacity
1 inch pipe size

You can now choose a specially designed Norgren MICRO-FOG Lubricator that has the bearing inch capacity that will provide the most effective lubrication for any machine.

Why Norgren MICRO-FOG Provides Better Lubrication

1. Norgren MICRO-FOG automatically supplies just the right amount of oil for lubricating machine components—no more, no less.
2. The advanced design of Norgren MICRO-FOG Lubricators makes possible complete machine tool lubrication with a minimum of air consumption.
3. Norgren MICRO-FOG remains suspended in the air stream and can travel many times farther than oil fog from conventional lubricators, and can be uniformly distributed to multiple lubrication points.
4. The delivery of Norgren MICRO-FOG to machine parts is precisely controlled. MICRO-FOG is delivered at a uniform rate regardless of the supply of oil in the reservoir.
5. Air-borne Norgren MICRO-FOG maintains a lower operating temperature for high speed parts—reducing wear, improving performance, increasing machine life.
6. The slight air pressure in bearing or gear housings prevents entry of foreign material.
7. 360° visibility of oil flow simplifies adjustment of oil feed rate, and provides visual assurance that the lubricator is operating.



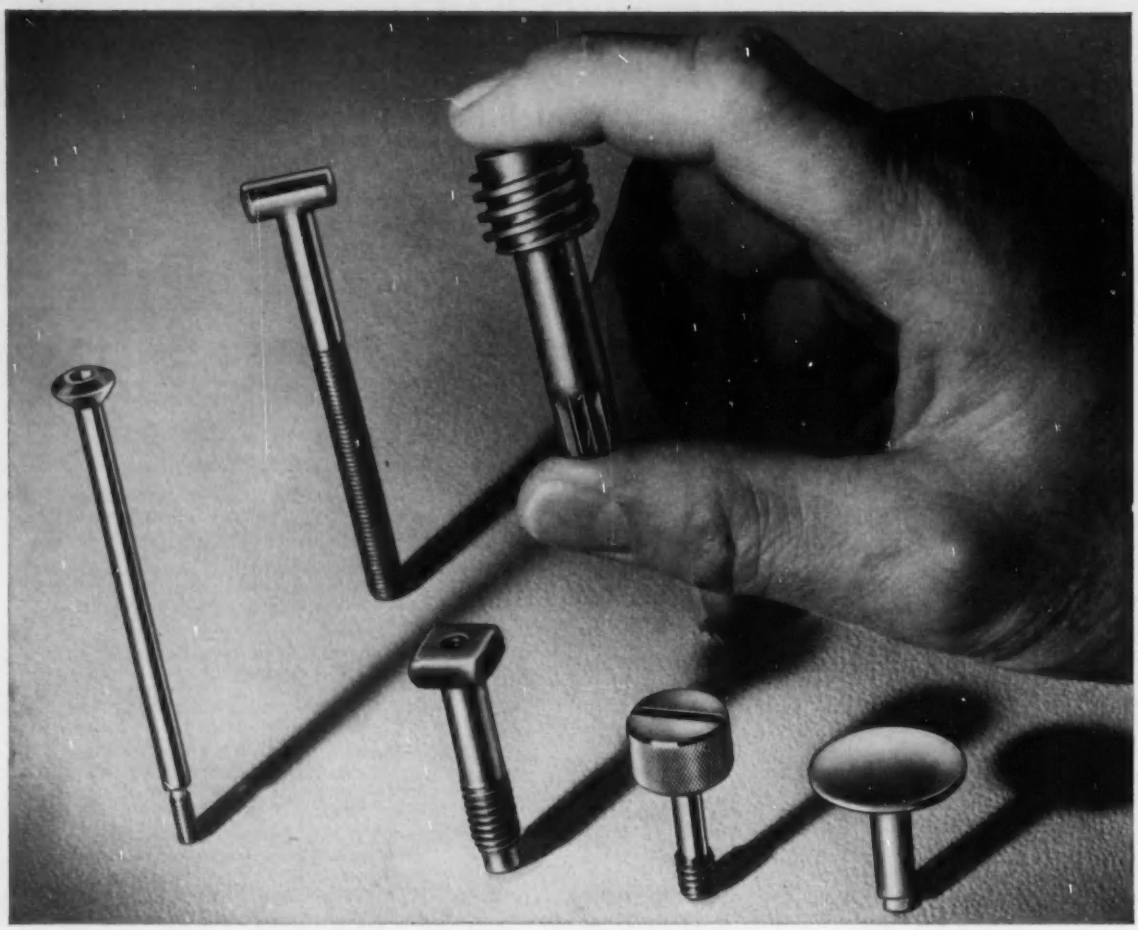
C.A. Norgren CO.

3428 So. Elati, Englewood, Colo.

For complete information about Norgren MICRO-FOG Lubrication, phone your nearby Norgren Representative listed in your telephone directory—or

WRITE FOR NEW NO. 700 CATALOG

PRESSURE REGULATORS • AIR LINE FILTERS • LUBRICATORS • AIR CONTROL VALVES



Tricky parts at big savings by Harper Flo-Form®

If you are using any parts like these that are milled from bar, Harper FLO-FORM can produce them for you faster, cheaper, with a better grain structure and without wasting costly alloys.

Harper engineers are specialists in producing parts from non-ferrous metals, stainless steel and high-temperature alloys. High skills in both cold and hot forming, by the Harper FLO-FORM process, make possible major cost reductions. Call your nearest Harper office for a field engineer or send your problem directly to us at Morton Grove.

Of course, if you use any standard type fastenings—bolts, nuts, screws, washers, rivets of corrosion-resistant metals—you are familiar with the extensive stocks of such fastenings available to you from Harper Distributors in every major market area.

THE H. M. HARPER COMPANY
8203 Lehigh Avenue, Morton Grove, Illinois

SPECIALISTS IN ALL CORROSION-RESISTANT FASTENINGS

OVER 7000 ITEMS IN STOCK...HARPER DISTRIBUTORS EVERYWHERE

HARPER
Everlasting Fastenings

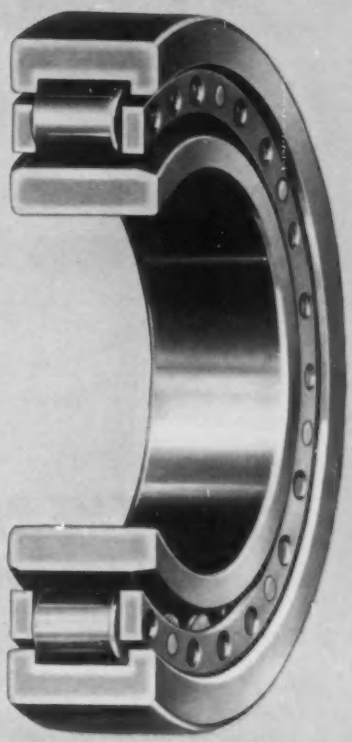
No job too little . . . or none too tough for BOWER STRAIGHT ROLLER BEARINGS

A complete line, a wide range of sizes to fit your specific needs

Square pegs weren't made for round holes. And aircraft bearings aren't built for farm equipment, either. That's why Bower designs a complete line of straight roller bearings—a line broad enough to meet any product requirement.

Jet planes break the sound barrier . . . need bearings that'll keep pace. So Bower aircraft bearings are engineered with exactness and precision to tolerances held to millionths of an inch. Bower tractor bearings, on the other hand, are built for ruggedness . . . to take heavy loads and real punishment, day after day, month after month.

Bower Roller Bearings are proved performers *in every field,* for *any* straight roller bearing application. From motors to earthmoving equipment, they're on the job—cutting maintenance and downtime, setting new standards of efficiency and economy. Get details on the *complete* line from a Bower engineer.



Tapered, Straight and Journal Roller Bearings for every field of transportation and industry

BOWER ROLLER BEARINGS

BOWER ROLLER BEARING DIVISION • FEDERAL-MOGUL-BOWER BEARINGS, INC., DETROIT 14, MICHIGAN

VIBRATION-DAMPING

SHOCK-ABSORBING

SKID-PROOFING

CUSHIONING

NOISE-KILLING

SCRATCH-PREVENTION

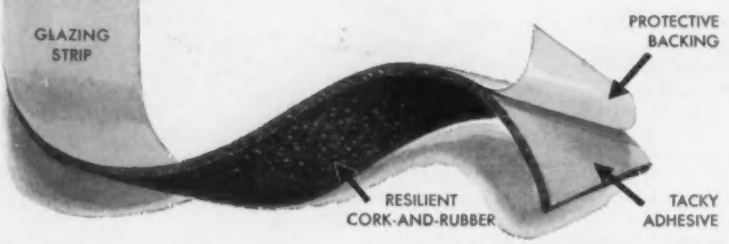
GLAZING STRIP

WEATHERPROOFING

Armstrong DK-153 Tape makes an effective gasketing material for many applications. In this parking meter, for example, it's used between the glass face and metal housing to seal out rain, dust, and dirt. This resilient cork-and-rubber material acts as a cushion, too—soaks up shocks, helps prevent glass breakage.

DK-153 is easy to apply. Just peel off the protective cloth backing and press the tape into place. Its tacky adhesive coating sticks tightly to any clean, dry surface.

You can get DK-153 in a variety of widths and thicknesses . . . in sheets, rolls, die-cut shapes. For samples, write on your letterhead to Armstrong Cork Company, Industrial Division, 7304 Irvin St., Lancaster, Pennsylvania.



Armstrong DK-153 TAPE

. . . used wherever performance counts

± 0.5 per cent on faster ranges. Silver-cadmium contacts rated at 15 amp have quick-make, quick-break wiping action and are of much larger size than previously used, with ample capacity for high inrush currents. Nine-position terminal block permits easier wiring from side or back with a wider range of circuit possibilities than before. Friction setting mechanism allows adjustment even while timer is operating. Tested mechanical and electrical life of the timers is well over a million operations.

The Type 412 timer automatically resets on power failure and begins a complete new cycle when service is restored. The Type 422 includes a special reverse action clutch which causes it to suspend operation in case of power interruption, resuming and completing the same cycle when service is restored. R. W. Cramer Co., Inc., Centerbrook, Conn.

For more information—
Circle 57, inside back cover

Automatic Marking Device

This unit can be connected to equipment to apply a distinct, waterproof indication on all types of surfaces, for batch counting, fault indication, registration coding and the like. It can be installed in any type of routine or special operation, ranging from complete automation to manual control. A wide choice of colors is available. The duration of the marking can be from fraction of second to minutes. Cosine Associates, Inc., 216 Newton St., Waltham 54, Mass.

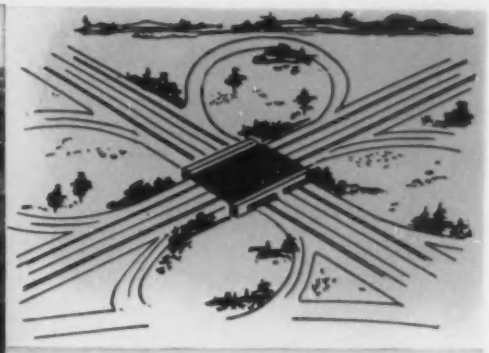
For more information—
Circle 58, inside back cover

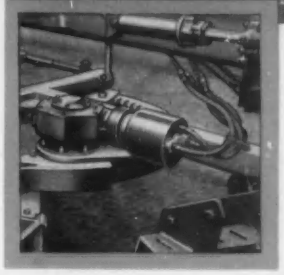
Bonding of Unlike Metals

Aluminum bonding to copper is accomplished by applying a coat of 50-50 or 60-40 (60 per cent tin and 40 per cent lead) to the copper surface, employing a minimum amount of flux or acid. Next one of the three bonding metals is applied to the aluminum surfaces by stroking the bar back and forth across the bonding area. This is to assure that aluminum surface oxides are absorbed by the bonding metal.

The two parts are brought into con-

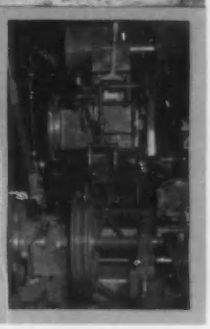
(Continued on page 276)





GALION 104 Motor Grader, above, uses Eastman Assemblies on *EIGHT* Hydraulic controls for more accurate, effortless and economical grading. Close-up, left, shows powerful Hydraulic Circle Turn for famous Galion "Reversible" Moldboard.

BARBER-GREENE Bituminous Finisher, right, automatically lays level finish for smoother, safer travel. Close-up shows Eastman Hydraulic Hose Assembly delivering 2,700 lbs. pressure to raise and lower finishing screed.



Smoother, Safer Roads

BUILT WITH HYDRAULIC POWER

DELIVERED THROUGH

Eastman

HYDRAULIC HOSE ASSEMBLIES

ALWAYS SPECIFY

EASTMAN Pressed-on, Reusable and Renewable Couplings for high and low pressure air, gas, water, paint, grease and hydraulic fluids. Eastman Straight and Angled Adapter Unions.

Smoother, safer highways are being built today through the application of modern engineering and the use of modern equipment—much of which is hydraulically operated—using Eastman Hydraulic Hose Assemblies.

GALION—pioneer builder of road machinery—whose Motor Graders and Rollers are used 'round the world—first used hydraulic controls as early as 1927. Eastman Mfg. Co. pioneered in the development of Hydraulic Hose Assemblies in 1926—and *Galion is Eastman equipped today!*

BARBER-GREENE—whose Bituminous Road Finishers have been used at one time or another on almost every road ever built—also uses Eastman Hydraulic Hose Assemblies. Hydraulic power is used to raise and lower the all-important mechanism which lays a level finish—regardless of irregularities in the base. Barber-Greene's founding date of 1916 closely parallels Eastman's of 1914—and *Barber-Greene is Eastman equipped today!*

EASTMAN—*first in the field*—is proud to have pioneers such as Galion and Barber-Greene—as well as many other leading American manufacturers—use Eastman Hydraulic Hose Assemblies. Look to Eastman for *continued leadership* in engineering and design for quality of material and workmanship—plus better-than-ever service through expanded production facilities of our new, modern plant.

SAFEGUARDING INDUSTRY'S *Lifeline of Mobile Power*

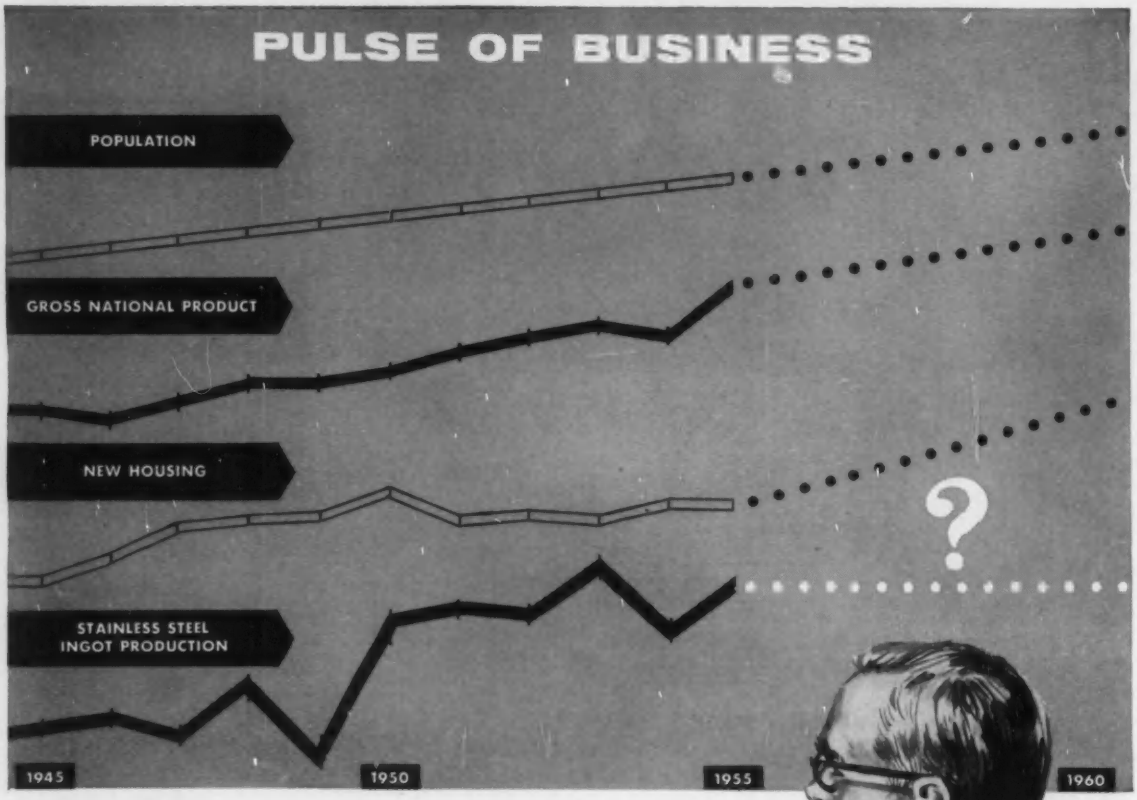
Eastman

first in the field

MANUFACTURING COMPANY

Dept. PE4, Manitowoc, Wis.

WRITE **for Eastman Catalog or send blueprints stating your hydraulic requirements and specifications.**



Can you grow with your markets?

As the national economy continues to expand so also will your markets. For you to grow with these markets there must be a corresponding increase in your supply of raw material. Right now, as in the case of stainless steel, this presents a problem.

If stainless steel sheet plays an important part in the manufacture of your product, you are more than likely accustomed to specifying Type 302, 18-8 chrome nickel grade. Due to government stockpiling of critical and strategic nickel, this particular grade is not as readily available as before and no immediate increase in supply can be expected. How then, if you are to increase your participation in this growth, can you overcome your problem?

THERE IS A WAY—another grade of stainless, namely Type 430, *is* readily available. Since it is a straight chromium stainless, it is not affected by the nickel shortage. Type 430 is by no means new and untried as it has been used extensively in strip form by the automotive and other industries. Over 30% of all stainless made in this country is the non-nickel bearing Type 430 produced primarily as strip and not as sheet.

Beside availability, the substantial savings in base price between 430 and the 18-8 grade is also of significant importance in these days of high prices. The amount you are presently spending for your stainless steel supply will buy considerably more stainless in the 430 grade, particularly in our MicroRold sheets.

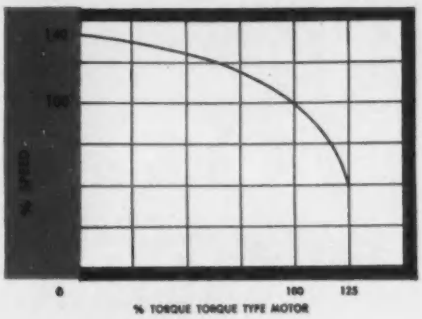
When applied properly in applications where extreme corrosion resistance is not a factor, Type 430 has all the desired qualities of beauty, strength, corrosion resistance, long life and low maintenance. The steel industry estimates that 50% of all stainless steel sheet applications could satisfactorily use Type 430 as an economical and practical material. If the product is cleaned regularly 430 stainless can be used in any application. Why don't you investigate the possibilities of Type 430 for *your* product?

Washington Steel
Corporation
4-G WOODLAND AVE., WASHINGTON, PA.

Send for your copy, "Care and Use of 430 Stainless"

Factors Determining the Choice of

HOWARD FRACTIONAL H.P. *INDUCTION MOTORS*

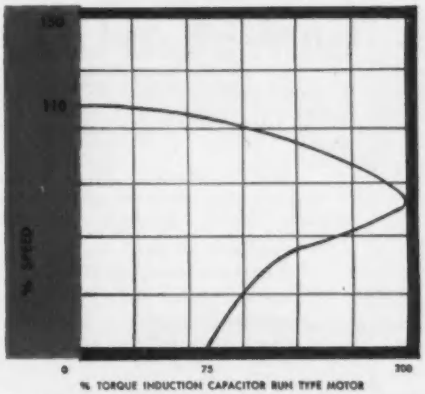


TORQUE TYPE MOTOR

POWER: AC 50 to 60 cycles.

CHARACTERISTICS:

1. No Load speed is determined by number of poles, with a No Load slip of approximately 5%.
2. Full Load speed decreases with an increasing load. Designed to operate at approximately 30% full load slip.
3. No breakdown torque.
4. Starting torque high approximately 125% full load.



INDUCTION CAPACITOR RUN TYPE MOTOR

POWER: AC 50 to 60 cycles.

CHARACTERISTICS:

1. No Load speed is determined by the number of poles, with a no load slip of 2 to 4%.
2. Constant Full Load speed, with a full load slip of approximately 10%.
3. Breakdown torque—approximately 200% full load.
4. Starting torque—approximately 75% full load.

HYSTERESIS SYNCHRONOUS TYPE MOTOR

POWER: AC 50 to 60 cycles.

CHARACTERISTICS:

1. Synchronized speed, determined by number of poles.
2. Starting torque equal to Full Load Torque.
3. Quiet operation.

RELUCTANCE SYNCHRONOUS TYPE MOTOR

POWER: AC 50 to 60 cycles.

CHARACTERISTICS:

1. Synchronized speed, determined by the number of poles.
2. Starting Torque Low, 50 to 75% of Full Load.

HOWARD

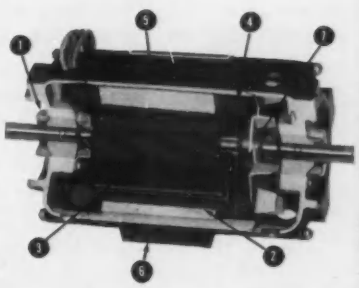
The increase in the use of Howard Induction Motors results from the overall superior performance characteristics of Induction motors over Series and Shaded Pole types.

basically Howard Induction motors have the following advantages:

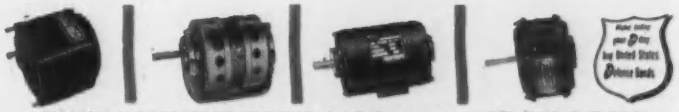
- Less maintenance—no brushes to wear, parts subjected to less wear. For applications where maintenance is difficult to handle.
- Constant speed under increasing load or varying power supply—for applications with exacting timing requirements where load or power supply are not constant.
- Extremely quiet operation both mechanically and electrically—for applications where noise level must be exceptionally low, professional tape recorders, etc.
- Low external field, in many cases requiring no magnetic shielding.
- Good efficiency up to 50% as against 40% maximum in Shaded Pole motors and 65% in Series motors.
- High power factor up to 85%.
- No radio or TV interference—for appliances and other home use applications.
- Good starting torque.
- Reversible in motion and reversible from rest.
- Wide range of H.P. ratings (1/8 to 1/1400) and gear ratios (2:1 to 3600:1).

Howard Induction Motors are currently used in a wide range of applications—business calculators, tape recorders, facsimile equipment, blowers for microwave relay stations, radar, projectors, teleprinters, gyro drives, automation instruments, etc.

Howard Induction Motors are available in Torque, Induction Capacitor Run, Hysteresis Synchronous and Reluctance Synchronous types. Costs are moderate but depend upon quantity. For full information on Howard Induction Motors, write for bulletin 56A.



1. "Selected" ball bearings permanently lubricated, sealed and shielded or sleeve bearings with large felt oil reservoirs with oil return system (shown). Sleeve bearing motors can be provided with ball thrust bearing for vertical operation or thrust loading.
2. 24 slot lamination design for quiet, cool operation. Stamped from high grade electrical steel.
3. Rotors dynamically balanced, skewed to give uniform torque characteristics with change of rotor angle.
4. Windings of heavy Formex insulated wire, impregnated and baked with top grade electrical varnish.
5. Case of sturdy, rigid casting always.
6. Mounting pads with holes drilled and tapped cast on frame. Special face mounting end bell available.
7. Internal fan for cooling.



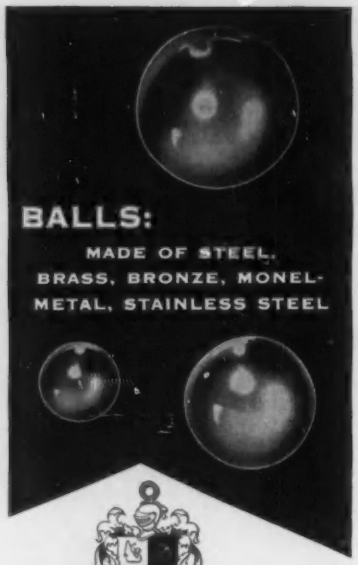
OTHER HOWARD MOTORS: UNIVERSAL & D.C.—1/200 to 1/2 H.P. • SHADED POLE—1/2000 to 1/10 H.P. • SERVO MOTORS • GEAR MOTORS • BLOWERS

DEPT. PE-4 • HOWARD INDUSTRIES, INC. • RACINE, WIS.

SALES OFFICES: 208 S. La Salle St., Chicago 4

942 S. La Brea Ave., Los Angeles 36 • Room 4822, Empire State Bldg., New York 1

DIVISIONS: EMC ELECTRIC MOTOR CORPORATION · CYCLOHM MOTOR CORPORATION · RACINE ELECTRIC PRODUCTS

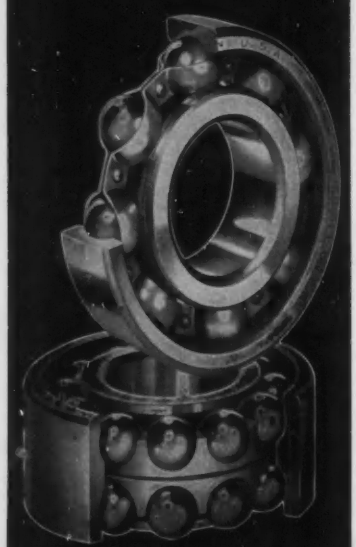


HOOVER

The Aristocrat of Bearings

BALL BEARINGS:

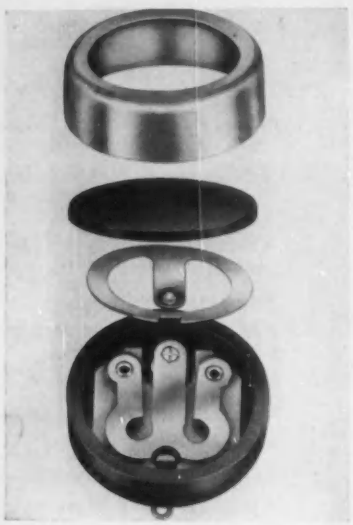
AMERICA'S ONLY
BALL BEARING WITH
HONED RACEWAYS



HOOVER BALL
AND BEARING COMPANY
ANN ARBOR, MICHIGAN

tact through pressure. Heat is then applied, depending on the type of bonding metal. Temperatures will range from 425 to nearly 1000 F. Precision Electronic Research Co., Glendora, Calif.

For more information—
Circle 59, inside back cover



Sealed Snap Switch

The fixed mounting of the W-shaped element used in this switch is said to assure maximum electrical conductivity to movable contacts. Further, the dual current path from solid anchorage of the W-blade to base provides high electrical rating compared to size. Electra Mfg. Co., 4051 Broadway, Kansas City, Mo.

For more information—
Circle 60, inside back cover

Double-Acting Cylinder

There is no metal-to-metal contact between the piston and the cylinder wall. This is achieved through the use of a nylon bearing wrapped around the outer diameter of the piston. The self-adjusting piston packings yield negligible "break-out" friction.

A cushion arrangement, with cadmium-plated spring, spherical radius seal and chamfered seat is asserted to assure positive cushioning with immediate acceleration on the return stroke. In addition to standard 1-in. stroke,

(Continued on page 280)

FOR NEW
AND BETTER
DESIGN
APPROACHES

to problems old and new

PLAN TO USE

GAM-EN-WOOD

GAMBLE ENGINEERED WOOD AND COMBINED MATERIALS

WOOD selected, defected, dimensioned, shaped; solid wood, laminated wood, sandwich materials;

wood-and-veneer
wood-and fiberglass
wood-and-plastics
wood-and-metals
wood-and-synthetics

any species, foreign or domestic, or combination of species.

Gamble Brothers' creative wood engineering has greatly extended the range of advantageous characteristics of wood and wood-combined materials for design application. The ingenuity of Gamble Brothers' product development staff and the knowledge born of more than fifty years of leadership in wood engineering are available to you—without obligation—just for the asking. Contact:

GAMBLE BROTHERS

Incorporated

4605 Almond Avenue,
Louisville 9, Kentucky

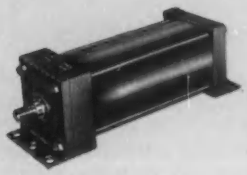
GAMBLE BROTHERS GB GUARANTEED HOLD

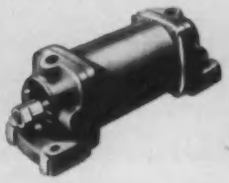
RIVETT FURNISHES A

complete POWER PACKAGE !

Get all your air and hydraulic needs from one source!
Over 500 standard models in all sizes for immediate delivery!

AIR CYLINDERS—168 Models





TIE ROD DESIGN

150 P.S.I. air; 250, 350, 500 P.S.I. oil. 8 mountings; 10 bore diameters; single or double end rod; internal or external thread; cushioning. J.I.C. Special covers. See Catalog 10.

KEEPER RING DESIGN

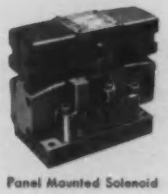
150 P.S.I. air; 300 P.S.I. oil. 7 mountings; 9 bore diameters; single or double end rod; internal or external thread; cushioning. Special covers. See Catalog 55.

HYDRAULIC VALVES—200 Models

Pipe Mounted Foot

Panel Mounted
Pipe Mounted
Direct Control
Functional

1500 and 3000 P.S.I. Standard, spring-return, spring-centered, ball detent. All piston designs. Hand, foot, cam, solenoid, solenoid pilot, oil pilot, air pilot. ¼", ⅜", ½", ¾", 1", 1¼", 1½", 2". See Catalog 204.



Panel Mounted Solenoid

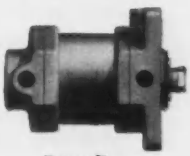
Panel valves conform to J.I.C. Greater flow; low pressure; shock resistant. Interchangeable sizes. See Catalog 261.

AIR VALVES—47 Models

Hand

150 P.S.I. 3 and 4-way. Hand, foot, cam, solenoid, and pilot. ¼", ⅜", ½", ¾" and 1". Pilot valves in side and foot mountings—palm, push-button, cam, foot, solenoid operation. See Catalog 303.

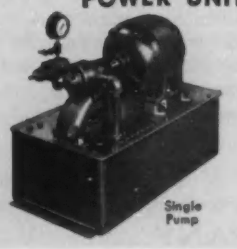
HYDRAULIC CYLINDERS—108 Models



Keeper Ring

300 and 1500 P.S.I.; 3000 P.S.I. furnished. 7 mountings; 10 bore diameters; standard and 2:1 over-size rod: single and double end rods, internal or external thread; cushioning. Special covers. See Catalog 106.

POWER UNITS—17 Models



Single Pump

1000 and 1500 P.S.I. Single pumps in six tank sizes. Capacities .4 to 40 G.P.M. Double pumps in four tank sizes with combined capacities 3.5 to 80 G.P.M.

CUSTOM-BUILT

Pressures to 5000 P.S.I. For unusual space, size, piping, valving, mounting, operation. See Catalog 400.

HANDY AIDS FOR AIR & HYDRAULIC CIRCUITS!

90 pages of working drawings, specifications, cut-away views. Get Free Copies Today!

The Better You Know Hydraulics
The Better You Like

RIVETT

RIVETT LATHE & GRINDER, INC.
Dept. PE-4 Brighton 35, Boston, Mass.

Member National Fluid Power Association

When does surface smoothness begin to waste your money?

In most plants today when a design engineer specifies a certain finish for a part, no one in production knows whether the part will be overmachined, O. K., or too rough until that part reaches the inspection department.

By then it is too late.

The costly consequence is that the company loses money on every part finished too well, AND on every reject resulting from underfinishing. Surface finish begins to waste your money at two precise points . . . *the moment you finish a part a single microinch better than the job requires, and the moment you finish a part a single microinch worse than required.*

Surprising as it may seem, most in-process checking today consists of judging how the finish *looks* and how it *feels* because no accurate, portable, in-process checking equipment has been available. The production department had no tool that could instantly tell the machine operator when he had met the specification.

The Brush Surfindicator takes the costly guesswork out of finish control. Fully portable . . . weighs only 15 pounds.

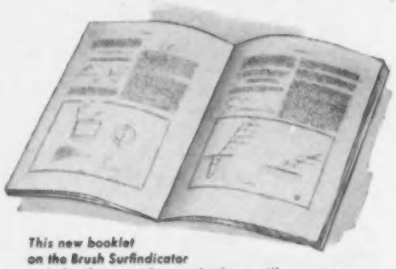
What has been done?

Brush has developed an amazingly rugged electronic surface measuring device called the SURFINDICATOR* which can be carried anywhere in the shop to obtain an instantaneous, accurate in-process measurement of roughness on any surface – flat, round or inside-a-hole.

Now you can set up optimum specifications for surface finish based on your laboratory or pilot model tests . . . and then hand a reliable instrument to the production department to help them meet those specifications with no waste of worker or machine time. You can mount SURFINDICATORS at each machine or set up checking stations throughout the plant. And your regular machine operators can use them . . . it doesn't take an expert.

How It Works

All the user does is pass the stylus over the surface in question and take a direct reading. It's simple, fast, accurate and above all it's practical . . . for metallic surfaces and for glass, porcelain, plastic, paper and other materials.



This new booklet on the Brush Surfindicator includes the new ASA standards . . . will help you establish economical surface finish control.

You should know all about this portable device, its many, many uses and the savings it can mean to your company. We tell the whole story in a new booklet which also includes the new ASA standards on surface finish for industrial use. Write for your copy today on your company letterhead. *T.M.

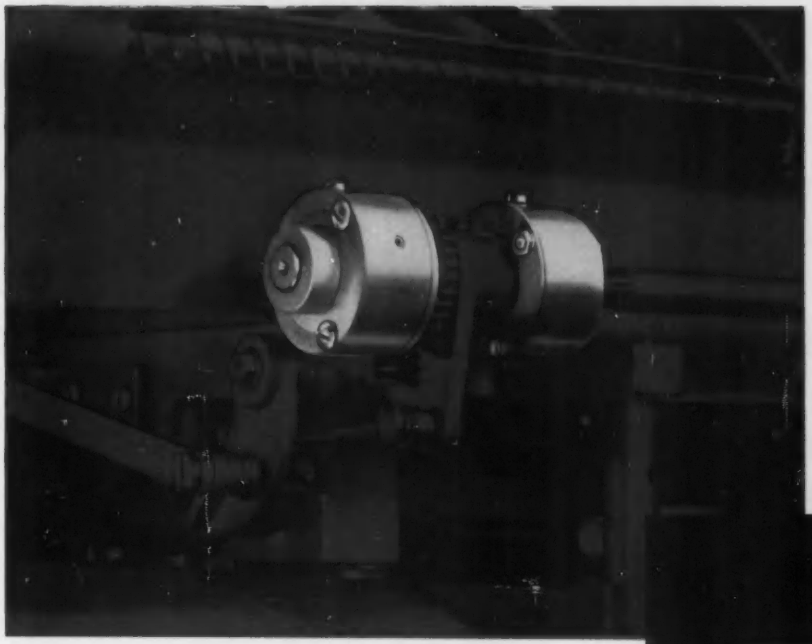
BRUSH ELECTRONICS COMPANY

3405 Perkins Avenue, Cleveland 14, Ohio

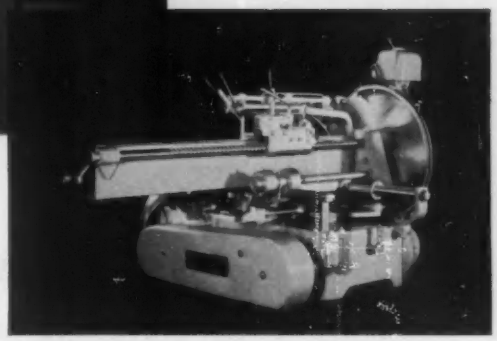
BRUSH ELECTRONICS

DIVISION OF CLEVITE CORPORATION

Morse Cam Clutches make slicing machine infinitely more accurate



Series 200 Cam Clutch with retaining end plate removed. This Cam Clutch Series fits standard Series 200 bearing housings.



Here's how they work:

The first Morse Series 200 Cam Clutch controls indexing (though not required on this job, it can handle up to 500 indexes per minute). When driven in one direction, inner and outer members rotate as one unit. When driven in the other direction, one member overruns freely, other member remains stationary. The second Cam Clutch is used to prevent backfeed between strokes.

Versatile, compact clutches can help designers control indexing, free-wheeling, backstopping

This modern slicing machine is infinitely more accurate because a Morse Cam Clutch replaces the old ratchet and pawl mechanism controlling the feed.

When U.S. Slicing Machine, Inc., used the ratchet and pawl, feed variations (slice thickness) could only be made in 1/128-inch increments. Now, the Morse Cam Clutch provides, in effect, a self-contained ratchet with an infinite number of teeth . . . and literally makes it possible for the machine to slice accurately to *any* desired thickness.

In addition, another Morse Series 200 Cam Clutch is used as a backstop device to maintain one-directional drive. It instantly engages to prevent backfeed between forward strokes.

Morse Cam Clutches are manufactured in capacities ranging from 4½ inch-lbs. to 20,000 ft.-lbs. Their low-cost accuracy and dependability make them ideal for a wide range of industrial indexing, overrunning, and backstopping applications.

Like other precision-built Morse power transmission equipment, they are quickly available from your local Morse Distributor. For more information, or free Catalog C 11-54A, call him, or write us today. **MORSE CHAIN CO., INDUSTRIAL SALES DIVISION, ITHACA, N. Y.**

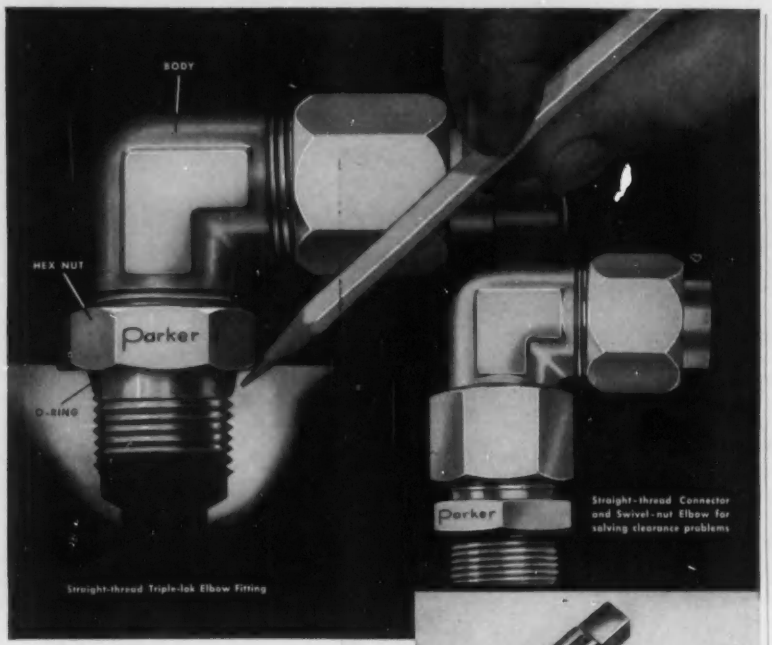
MORSE

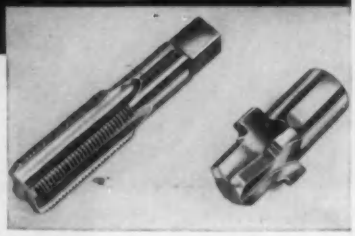
MORSE BW *trademark

POWER TRANSMISSION PRODUCTS

The MATERIAL HANDLING INSTITUTE'S EXPOSITION
Cleveland, Ohio
PUBLIC AUDITORIUM
JUNE 5th THRU 8th, 1956
BOOTH 1201

THE MATERIAL HANDLING INSTITUTE, INC. mhi





Precision thread-tapping and counterboring tools for making accurate *straight*-thread boss (to receive these new Parker *straight*-thread fittings) are now available with machining drawings from Parker.

New Parker *straight*-thread fittings solve your leakage problems

Now you can forget about high-pressure hydraulic problems resulting from tapered pipe threads. Forget about leakage . . . about the danger of cracking or distorting valve bodies by over-tightening the fittings . . . about damaged threads from over-tightening to obtain proper positioning. Forget about messy pipe "dope".

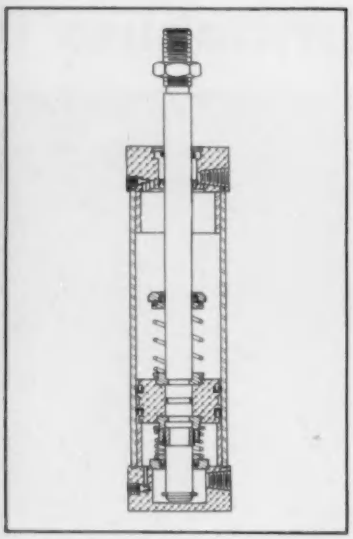
You can eliminate all of these problems by using new Parker *straight*-thread fittings with positive O-ring seals. (See illustration above.)

Parker *straight*-thread fittings are now being supplied in response to the growing demand for this new type of leakproof, trouble-free connection. They are shorter and have smaller hexes than the AN fitting for the old AND 10050 boss. *Straight* threads are available on *Triple-lok* (the industrial standard flare tube fitting) and on *Ferulok* (flareless fitting for heavy steel tubing).

This is another example of Parker's pioneering leadership in the field of hydraulic fittings. Write for Cat. 4301.

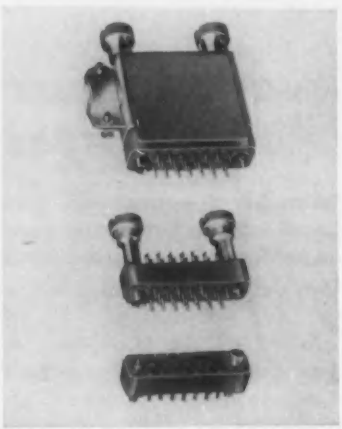
TUBE AND HOSE FITTING DIVISION
Section 414-L
The Parker Appliance Company
17325 Euclid Ave., Cleveland 12, Ohio

Parker
Hydraulic and fluid system components



adjustable cushions for controlled strokes over 1-in. and up to 6-in. are available. Three-way flush rabbet mountings, front, rear, and horizontal, are standard. Capable of operating under 250 psi (air) or 500 psi (water and oil), these cylinders exceed JIC standards. Alkon Products Corp., 206 Central Ave., Hawthorne, N. J.

For more information—
Circle 61, inside back cover



Jackscrew Locking Device

The actuating side of the lock consists of two screws, each having knurled, cross-slotted knobs to permit locking either by hand or screwdriver. The mating connector half encloses the two fixed screws required to complete the lock action. The design pro-

(Continued on page 284)

NOW...IN ROLLS

CLEARPRINT "FADE-OUT" PAPER

Clearprint "Fade-Out" Paper is especially well adapted for heating, wiring, plumbing and electrical diagrams...for structural and architectural drawings...for plant layouts and tool designs. See how Clearprint can reduce your drafting time and costs. Order a trial roll now, and apply it to your various needs.

Make This Convincing CLEARPRINT TEST

1. **INVITES PENCIL AND PEN** — Try Clearprint's perfect working surface with a 2H pencil, then with a ruling pen. Lines are sharp and clean — no feathery edges.

2. **ERASES PERFECTLY** — Erase some of the lines. Redraw and erase several of them repeatedly. Crease the paper, too. Then hold it to the light and notice the absence of grid lines and ghosts.

3. **NO GRID, NO GHOSTS ON PRINTS** — Make a quick print of the sheet. The original is faithfully reproduced, clean and easy to read, without erasure ghosts or cross section rulings.

THERE'S A CLEARPRINT PAPER FOR EVERY JOB

ASK FOR COMPLETE SAMPLE BOOK

IN SHEETS, PADS and ROLLS

AVAILABLE in ROLLS up to 42" wide, and in SHEETS of any specified size. RULINGS 8 x 8 and 10 x 10 lines to the inch with inch lines heavy.

PRINTED on Clearprint Technical Papers:
No. 1000H — 16 lb. weight
No. 1020 — 20 lb. weight

SEEING is BELIEVING!

Ask your dealer for samples, or send coupon

CLEARPRINT®

"FADE-OUT" PAPER

THERE IS NO SUBSTITUTE — Demand Watermarked Clearprint

CLEARPRINT PAPER CO. (PE)
1482 - 67th St., Emeryville, Calif.

- ☐ Please send me sample Clearprint "Fade-Out" sheets, with prices.
- ☐ Send me Clearprint samples, with prices, for following uses: _____
- ☐ Have your representative call at my office

Name _____
Firm _____
Address _____
City _____ Zone ____ State _____

1

Most Positive Bearing For Dirt Exclusion and

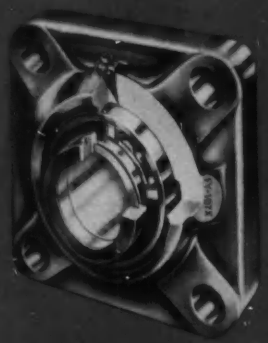
now – a complete line of unit pillow blocks

New

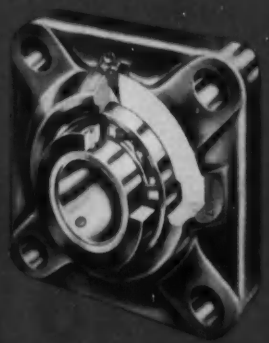
TYPE SYH-X
UNIT PILLOW BLOCK
For eccentric lock shaft mounting — interchangeable with pillow blocks having reduced center heights.

TYPE SY
UNIT PILLOW BLOCK
For set screw shaft mounting.

New



TYPE FY-X
UNIT FLANGED MOUNTING
For eccentric lock shaft mounting.



TYPE FY
UNIT FLANGED MOUNTING
For set screw shaft mounting.

Designers!

HERE'S HOW SKF HELPS MAKE YOUR PRODUCT BETTER

In offices throughout the U.S.A., SKF maintains the bearing industry's most experienced sales engineering staff. If bearings are part of your product, call the nearest SKF District Office for any engineering assistance you may need.

Operating Men!

LOOK FOR THE SIGN OF YOUR AUTHORIZED SKF DISTRIBUTOR

It is your guarantee of complete stocks and unbiased engineering assistance because only your SKF distributor stocks all types of bearings—ball, roller, spherical and tapered roller. You'll find his name in the classified telephone directory.

BALL BEARINGS CYLINDRICAL ROLLER BEARINGS SPHERICAL ROLLER BEARINGS

Seal Ever Devised Lubricant Retention...

...fully interchangeable with other makes

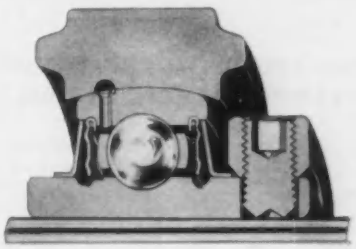
SKF UNIT PILLOW BLOCK FEATURES

- Long inner ring distributes load over greater shaft area.
- The spherical outer ring of the bearing compensates for initial misalignment.
- Interchangeable with existing bolt-hole spacing and center height.
- Grease fitting in housing for relubrication of bearing.
- Bearing is easily replaced.
- Bearing is pre-lubricated and sealed at SKF — it's ready for operation.
- All housings are cast in one-piece for durability.

Special Features

Shown on the right is SKF's Bearing Seal Design which is the most effective ever developed. The seal itself, made of a specially designed metal backing plate and a Du Pont Fairprene washer, is staked into the bearing outer ring and makes *light* but *positive* contact with a groove in the bearing inner ring—a contact seal that acts as a relief valve and *can't pop out* when lubricant is added. This Red Seal is augmented by a rotating flinger—together they provide positive dirt exclusion and lubricant retention. 7701

SKF RED SEAL



SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.
—manufacturers of **SKF** *and* HESS-BRIGHT® *bearings.*

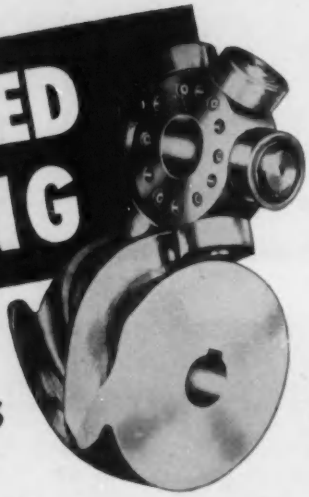
SUBSIDIARY

TYSON BEARING CORPORATION, MASSILLON, OHIO
—manufacturers of Tyson *tapered roller bearings.*

SKF®
BEARINGS AND PILLOW BLOCKS

Tyson TAPERED ROLLER BEARINGS

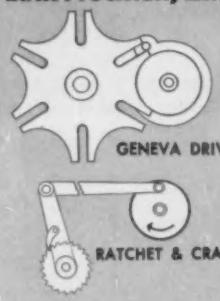
HIGH SPEED INDEXING



UP TO 1,000 PRECISION INDEXES PER MINUTE *with the*

FERGUSON DRIVE!

Geneva Drives and Other Obsolete Indexing Devices Lack Precision, Limit Production and Wear Excessively...

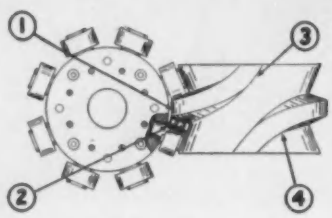


Geneva drives have abrupt acceleration characteristics. When operated at high speeds to correspond to the capacity of the rest of the machine, the tremendous shock of the sudden starts and stops soon wears out the drive and other parts of the equipment and causes vibrations and backlash that effect product quality. The plain fact is: *geneva drives limit the production of many otherwise modern machines!*

Ratchet and crank mechanisms have almost instantaneously applied accelerations. Speeds must be kept down to hold dynamic forces within limits. Even with strong auxiliary braking action, overtravel is extreme and accuracy very poor.

Of all types of indexing devices, only the Ferguson Drive has all the advantages of high speed, precision, low maintenance and design versatility!

HERE'S WHY THE FERGUSON DRIVE DOES WHAT NO OTHER INDEXING MECHANISM CAN DO . . .



1. .001" Precision; Zero Backlash

Preloaded ball bearing followers roll along tapered sides of hardened and ground cam rib. Two rollers are in contact with rib at all times. While in "rest" position, followers are engaged and locked with zero backlash by straight portion of rib. No auxiliary locking is required. *Built-in precision permits operation at maximum speed.*

2. Lower Maintenance

Ferguson Drives are rated for a minimum of 8,000 hours precision operation. When finally necessary, the Drive may be renewed for a like period by replacing standard ball bearings. *Cams have been in use for 25 years with no signs of wear!*

3. High Speed Indexing

Selection of movement and timing are independent. "Wasted" rest time can be utilized. Movement time can be reduced. *Modified trapizoid acceleration permits operation at speeds up to 1,000 indexes a minute without effecting the Drive, machine or product adversely!*

4. Reduced Vibrations

The modified trapizoid acceleration gives smooth starting and stopping, with minimum shock and vibration. In many cases where the Ferguson Drive has replaced a geneva drive, production has increased as much as 100%. *The Ferguson Drive may do this for your production machinery, too!*

Write for Catalog of Stock and Standard Ferguson Drives

FERGUSON MACHINE & TOOL CO., INC.

ROLLER GEAR DIVISION, DEPT. B-4 P. O. BOX 5841, ST. LOUIS 21, MO.

vides for connector polarization, since both a male (externally threaded) and female (internally threaded) screw are on the same connector half. Winchester Electronics, Inc., Dept. K, Norwalk, Conn.

For more information—
Circle 62, inside back cover

Silicon Power Rectifier

These miniature silicon rectifiers have peak inverse voltage ratings up to 600 v, and will handle up to 400 ma at 135 C. No voltage or current derating is necessary throughout their operating temperature range of −55 C to 135 C. Stringent environmental specifications, including 500G shock test and 5000G centrifuge test, are included to insure reliability under the most severe operating conditions.

These rectifiers are intended for power supply, magnetic amplifier and other rectifier applications where minimum size and weight are important. Transitron Electronic Corp., Melrose 76, Mass.

For more information—
Circle 63, inside back cover

Knob Lock

A locking device for use on potentiometers and other electronic controls mounts on the control bushing, replacing standard mounting hardware. It provides a means of maintaining critical control settings under conditions of shock or vibration.

An eighth-turn of the knob's fluted skirt forces a circular neoprene shoe against the inner face of the control

(Continued on page 289)

SEE FOR YOURSELF

As you can see, the full face width of each gear in a Farrel speed reducer is at work, transmitting power.

Instead of a center groove, Farrel gears have a ***backbone*** formed where the helices meet. This ***backbone*** provides extra strength, and greater load-carrying and shock capacity — especially important in tough-job applications.

What you can't see, but which is equally important, is that these gears have teeth generated by the famous Farrel-Sykes method—assuring accuracy of tooth spacing, profile and helix angle. This accuracy pays off in smooth, quiet, uniform power flow.

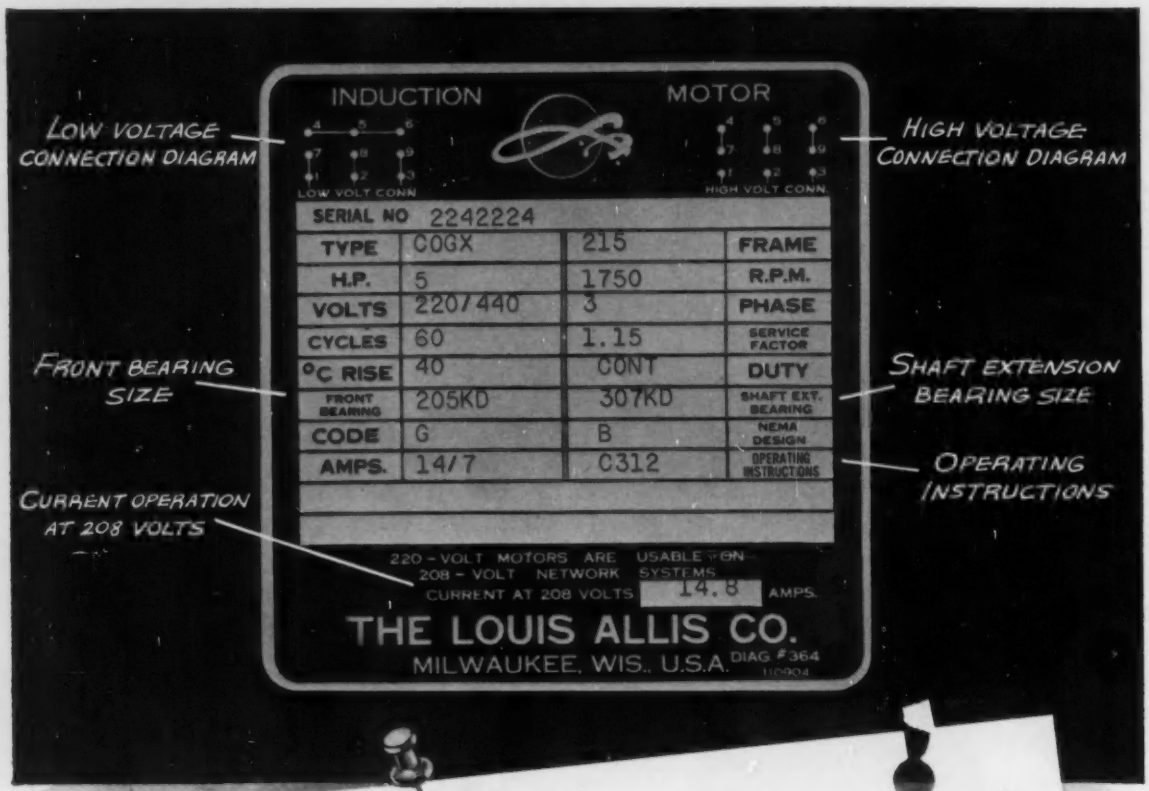
Farrel speed reducers are made in a number of types, with a wide range of ratios and capacities. For more about these long-lived units ask for a copy of bulletin 449.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT

Plants: Ansonia and Derby, Conn., Buffalo and Rochester, N.Y.
Sales Offices: Ansonia, Buffalo, New York, Boston, Akron, Detroit, Chicago, Memphis, Minneapolis, Fayetteville (N. C.), Los Angeles, Salt Lake City, Tulsa, Houston, New Orleans

FB-991

Farrel-Birmingham®


LOW VOLTAGE CONNECTION DIAGRAM
INDUCTION MOTOR
HIGH VOLTAGE CONNECTION DIAGRAM
LOW VOLT CONN.
HIGH VOLT CONN.
SERIAL NO 2242224
TYPE C0GX 215 FRAME
H.P. 5 1750 R.P.M.
VOLTS 220/440 3 PHASE
CYCLES 60 1.15 SERVICE FACTOR
°C RISE 40 CONT DUTY
FRONT BEARING SIZE
FRONT BEARING 205KD 307KD SHAFT EXT. BEARING
SHAFT EXTENSION BEARING SIZE
CODE G B NEMA DESIGN
AMPS. 14/7 C312 OPERATING INSTRUCTIONS
OPERATING INSTRUCTIONS
CURRENT OPERATION AT 208 VOLTS
220 - VOLT MOTORS ARE USABLE ON 208 - VOLT NETWORK SYSTEMS.
CURRENT AT 208 VOLTS 14.8 AMPS.
THE LOUIS ALLIS CO.
MILWAUKEE, WIS., U.S.A. DIAG. #364

why is this nameplate important to you?

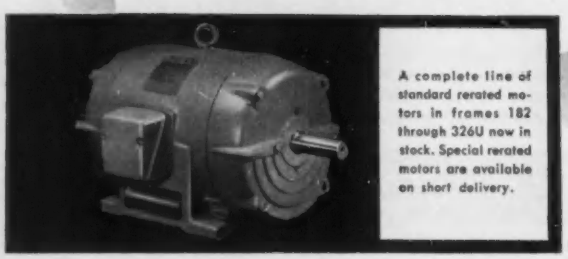
It provides visible evidence that Louis Allis standard motors are built with special care to run better, last longer . . .

Look at the information on this nameplate—information that makes life a lot easier for the user. And to keep this information available at all times, we make this nameplate out of corrosion-resistant stainless steel.

Yes, in the new LA line of standard motors, even the nameplate gets special attention from our engineers. And here's what it means to you:

- The rerated frame size shown means more horsepower from motors with smaller outside dimensions. Performance has been improved by new materials and manufacturing methods.
- Spare bearings can be easily ordered from bearing size and type designations on nameplate, thus eliminating disassembly of motor to determine bearing size. Bearings used are conservatively rated for long life.
- No more lost connection diagram since this information is simply and clearly shown on nameplate. This combined with permanent lead markings, assures that correct motor connections can always be made.
- 220/440 volt motors are suitable for operation on 208 volt systems and full load current for 208 volt operation is included on the nameplate. This eliminates need for original equipment manufacturers to carry a stock of 208 volt motors.

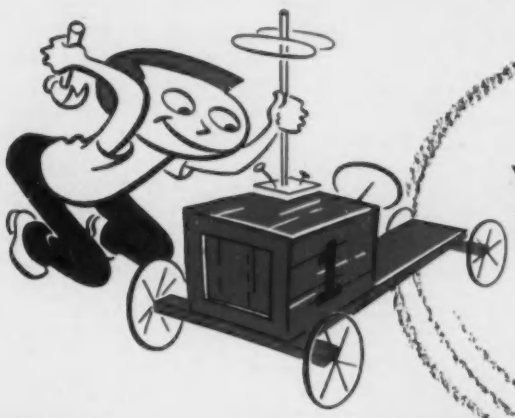
Because they are built with special care, new LA standard motors can do a lot more for you. New bulletin No. 1700 shows you why—just write for your copy.



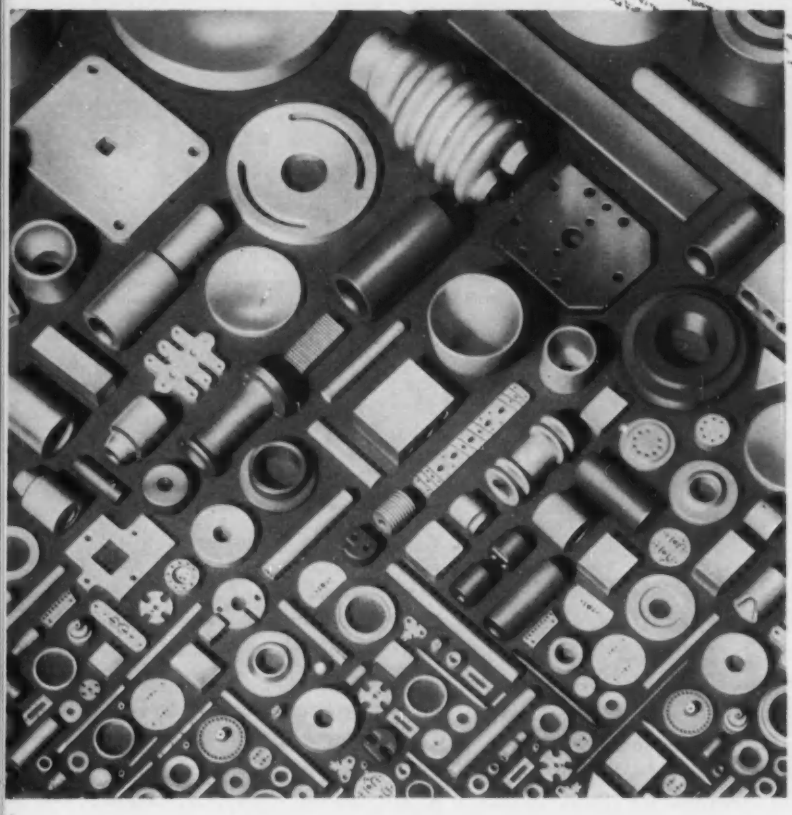
A complete line of standard rerated motors in frames 182 through 326U now in stock. Special rerated motors are available on short delivery.

LA-106

THE LOUIS ALLIS CO.
MILWAUKEE 7, WISCONSIN



Improve your product with ALSIMAG® ALUMINA CERAMICS



STRENGTH. High compressive, flexural and tensile strengths.

STABILITY. Successfully withstand radiation bombardments and elevated temperatures without producing contaminants.

HARDNESS. Extremely hard, 9 on Mohs' scale. Resist wear and abrasion of most known materials.

UNIFORMITY. Manufactured under the most rigid standards of Quality Control. Shipped within your tolerance spread.

RUGGEDNESS. Resist mechanical shock, vibration and high ambient or operating temperatures.

CHEMICAL INERTNESS. Will not rust, corrode or deteriorate with time.

PRECISION TOLERANCES. Can be fabricated to extremely close tolerances on dimensions. Parts as thin as .009" are practical in production quantities.

SURFACE FINISHES. Surfaces may be ground or polished to 10 micro-inches RMS or better.

HEAT SHOCK RESISTANCE. Not affected by elevated temperatures. Withstand repeated hot-cold shock.

THERMAL CONDUCTIVITY. Dissipate heat by rapid thermal conduction.

SUPERIOR ELECTRICAL CHARACTERISTICS. Markedly superior electrical characteristics even at extremely high frequencies and elevated temperatures.

THE ANSWER TO YOUR PRODUCTION PROBLEMS MAY BE ALSIMAG ALUMINA CERAMICS! Why not investigate? Send us a blueprint or sketch along with details of your operating procedure, for complete details. Special Alumina Bulletin on Request.

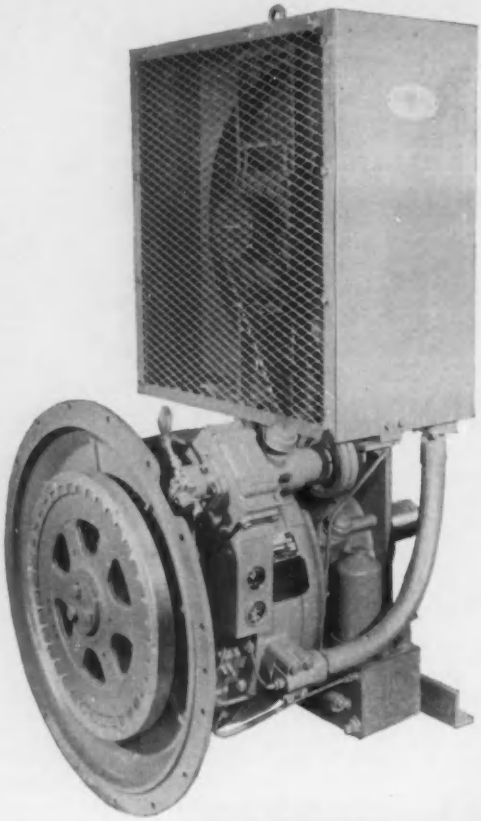
PLANTWIDE VACATION
First two Weeks of July

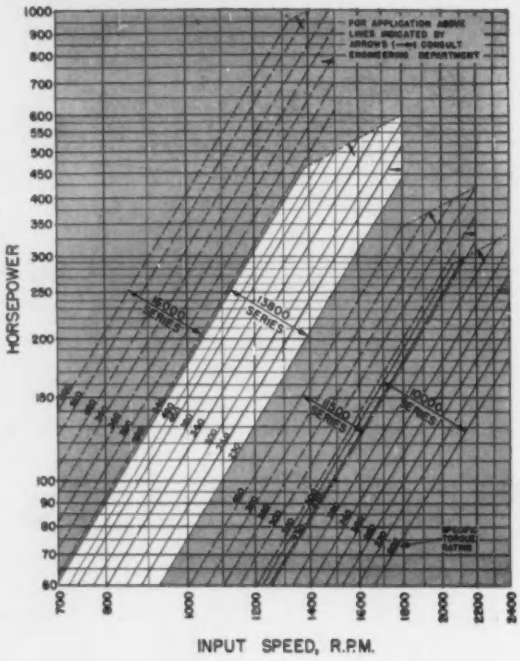
55TH YEAR OF CERAMIC LEADERSHIP

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENNESSEE
A Subsidiary of
Minnesota Mining and Manufacturing Company

Branch offices in these cities (see your local telephone directory): Cambridge, Mass. • Chicago, Ill. • Cleveland, Ohio • Dallas-Houston, Texas • Indianapolis, Ind. • Los Angeles, Calif. • Newark, N. J. • Philadelphia, Pa. • St. Louis, Mo. • South San Francisco, Calif. • Syracuse, N. Y. • Tulsa, Okla. **Canada:** Irvington Varnish & Insulator Div., Minnesota Mining & Mfg. of Canada, Ltd., P. O. Box 757, London, Ontario. **All other export:** Minnesota Mining & Mfg. Co., International Division, 99 Park Ave., New York, N. Y.





ENGINE APPLICATIONS

Eng. Mfg.—Model	Eng. Mfg.—Model	Eng. Mfg.—Model
Allis-Chalmers PCJ879	Climax V-330	Mercedes-Benz MB836-BG
Allis-Chalmers DC1879	Climax V-85	MGO V8I
Allis-Chalmers DSC-1879	Cummins LRI	MGO V12
Allis-Chalmers PCS-1879	Cummins NVHS	Murphy Z4
Allis-Chalmers PC2505	Cummins VT-12	Murphy 122
Cat D-342	Deutz BA8M517	Murphy 322
Cat D-8	Fairbanks 38F5-1/4	Rinman VERPHIL
Cat D-364	Gardner 6-L3	Sauer —
Cat D-9	Hall Scott V-12	Sterling V-06
Cat D-375	LeRoi H-1500	Waukesha RKO
Cat D-38E	LeRoi H-200	Waukesha NKR
Climax R-81	M.A.N. SWV175/122-A	Waukesha NKOS
Climax V-285	M.A.N. GWV-175/122-A	Waukesha LRO
	Mercedes-Benz MB836-B	

ANNOUNCING . . . the new Twin Disc 13,800 Series Three-Stage Torque Converter

By W. B. Gibson, Sales Manager

Hydraulic Division, Twin Disc Clutch Company, Rockford, Illinois

With announcement of the new 13,800 Series, the Twin Disc Clutch Company *now* provides a three-stage torque converter for every horsepower range from 40 to 1,000—offering four distinct sizes, with a total of twenty-nine capacities, through internal blading variations.

Designed specifically to accommodate a large number of engines for which previous models were not ideally suited (see listing above)—this new series is planned around a *simple basic unit*—with easy-to-add components which produce ten specific models. This arrangement permits extreme flexibility and speedy interchange of components to provide a model specifically adapted to a wide variety of applications.

The 13,800 Series provides two *output* arrangements. There is *one standard output shaft assembly* designed for maximum side pull loads up to the full capacity of the converter. On this particular output shaft assembly, an output governor take-off is available. There is also *one standard output flange* designed for universal joint or flexible gear coupling drive.

There are also three *input* arrangements—spider drive, incorporating a rubber block drive — which withstands normal misalignment conditions without imposing undue loads or stresses on the input shaft or the engine crankshaft; clutch assembly and independent mounting. In addition to being offered in ten different models, this new torque converter can be adapted, with appropriate engine speeds, to all engines in the 60 to 600 horsepower range by internal blading variations.

Get all the facts on the advantages of torque converter drive in equipment that *you're* planning or designing. Write *now,* to the Hydraulic Division, Rockford, Illinois.

Twin Disc Clutch Company
Racine, Wisconsin
Hydraulic Division, Rockford, Illinois

knob, locking the knob firmly without affecting the angular position of the control shaft. Raytheon Mfg. Co., Waltham 54, Mass.

For more information—
Circle 64, inside back cover

Toggle Switch "Remembers"

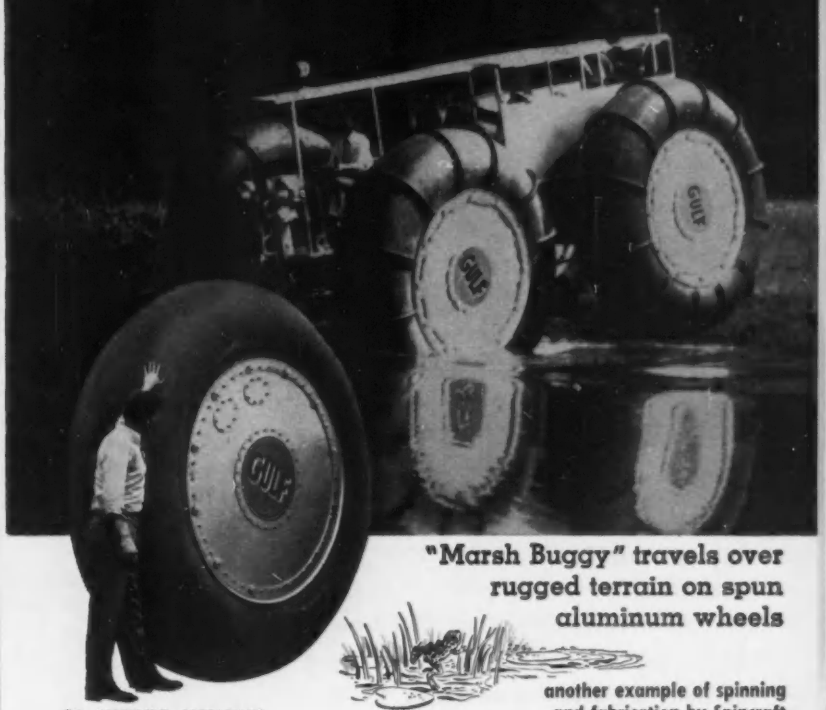
A toggle switch with an "electrical memory" is a four-pole assembly with one pole for indicating which circuit was last operated. Three single-pole, double-throw functional basic switches and one single-pole, double-throw "memory" switch are used. In application, the memory switch indicates through a pilot light or buzzer which circuit was last actuated. The three functional switches operate at three lever positions; maintained center and momentary from each extreme position. Two of the switches are actuated when the lever is moved to one extreme position and the other switch is actuated in the other extreme position.

The basic switch, which is used for the "electrical memory", is actuated (maintained) in one extreme lever position and is released (maintained)

(Continued on page 292)

Spincraft did it for Gulf Oil...

Spincraft can do it for you!



"Marsh Buggy" travels over rugged terrain on spun aluminum wheels

another example of spinning and fabrication by Spincraft

13 DIFFERENT OPERATIONS

The "Marsh Buggy" rolls on sturdy, lightweight aluminum wheels — spun and fabricated by Spincraft. Even if all four balloon tires fail, the spun aluminum air-tight wheel drums will keep the vehicle afloat. Wheel flange segments, extensions, .118" thick 52SO aluminum stiffener ribs, No. 11 U. S. gauge (.125" thick) stainless steel front hub cones were machined and assembled to complete the wheels. In addition to spinning, Spincraft performed the following operations: welding, grinding, polishing, machining, punching, braking, drilling, tapping, sawing, riveting, assembly and testing.

Write for Spincraft data book. If you have a specific problem, tell us about it — no obligation.

WHEN Gulf Research & Development Co., a division of Gulf Oil Corp., contracted to build their world-famous "Marsh Buggy" for the U. S. Army, Gulf called on Spincraft to fabricate all four wheel assemblies.

These huge wheels are designed to bear loads of 1,500 to 4,000 lbs. Combining strength with lightweight, these tough aluminum alloy wheels can take grueling cross-country punishment. The 10-ft. dia. tires easily negotiate swamp, water, sand, deep mire and other difficult terrain, at speeds from ¼ to 40 miles per hour.

This is another example of Spincraft's versatility and manufacturing skill. Complete facilities are available for all types of contract manufacture — finished parts, assemblies and complete products. Take advantage of our modern tools for spinning and fabricating. They can pay off in savings for you, too.

WORKSHOP OF AMERICAN INDUSTRY SINCE 1919

World's largest plant fully equipped for all types of metal spinning • deep drawing • stamping • fabricating

Spincraft
SKILL WILL DO IT
INCORPORATED

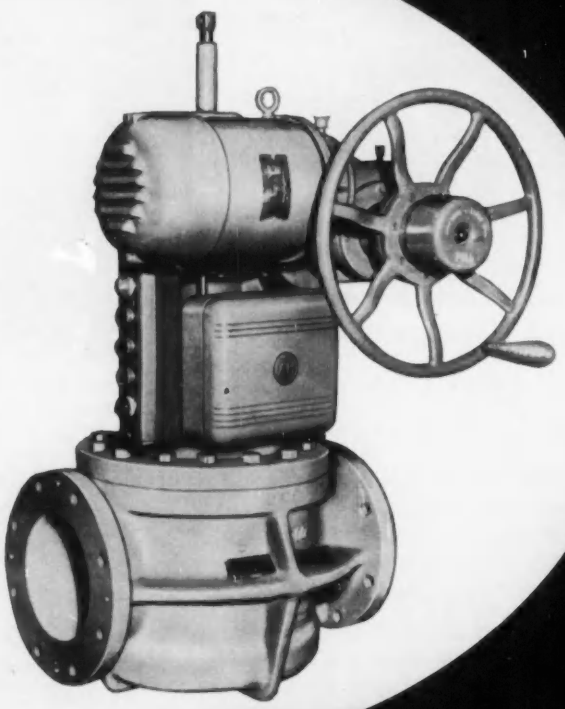
4124 WEST STATE STREET • MILWAUKEE 8, WISCONSIN

ROTARY VALVE DRIVES

by

Janette

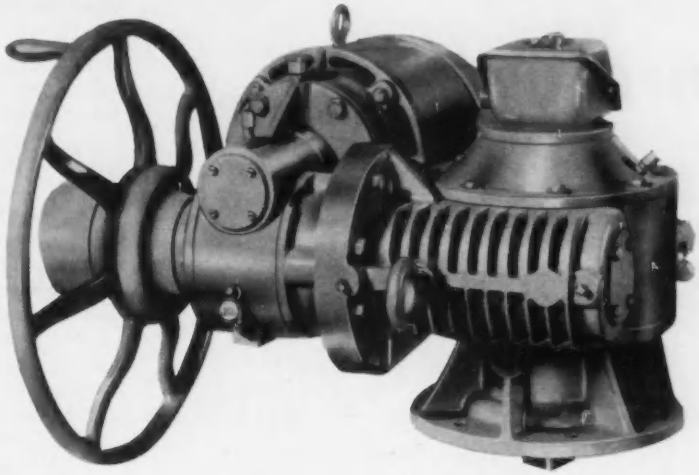
"ALL IN ONE – BUILT BY ONE"



Incorporating all of the time tested engineering principles of Janette power drives, an advanced line of Rotary Type Valve Drives is presented to meet the needs of oil, gas, water, sewage, and other types of installations.

Janette Rotary Type Drives are of the same general design and construction as those used extensively in Atomic Energy Plants, where performance and durability are vital. Built as a single unit, housings are sturdy, compact and weather-proof. Twelve assembly positions are available, with standard gear ratios of one and two R.P.M., and one thousand other options to meet special requirements.

Janette



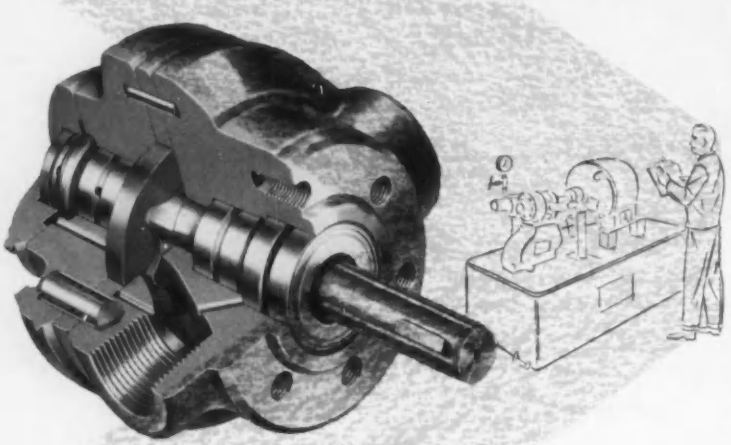
A BRILLIANT ENGINEERING ACHIEVEMENT BY AMERICA'S BEST KNOWN MANUFACTURERS OF POWER DRIVES FOR INDUSTRY

Write for new illustrated brochure, with catalog pages giving complete specifications of eight available models. Of special interest to designers and engineers. Your letterhead is all that is required.

Electric Mfg. Co.

MORTON GROVE, ILLINOIS

Gerotor Hydraulic Pumps



give Higher Efficiency at Lower Operating Cost!

All Gerotor hydraulic pumps are recognized throughout industry for their outstanding design and performance. Heart of each unit is the exclusive *Gerotor* mechanism, both elements of which revolve in the same direction at relative low speed. This results in *longer life, less slippage, less wear,* a *smoother,* more *uniform flow.* In your plant or in your product—a GEROTOR pump means *higher efficiency* at *lower operating cost.*

Due to modern production facilities, GEROTOR can produce special pump designs in *quantities* on an economical basis. Whatever your hydraulic pump problems, bring them to GEROTOR.

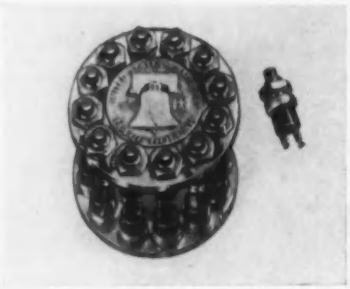
Free literature available . . . *write:*

GEROTOR
MAY CORPORATION
MANUFACTURERS OF—
1511 MARYLAND AVENUE, BALTIMORE 3, MARYLAND

in the other extreme position. The lever returning to the center position does not affect the memory switch, which indicates the extreme position in which the lever is in, or was in, most recently.

The switch is provided with a 15/32-32 bushing, hex nut, lock washer, and keying tab for one-hole mounting in 7/32 in., max, panel or bracket. Panel sealing is provided by a panel gasket seal and an internal bushing seal to prevent entrance of liquids and dust. The basic switches are UL-listed at 5 amp, 125 or 250 v, ac. Their d-c rating at 30 v is: inductive, 3 amp at sea level and 2.5 amp at 50,000 ft; resistive, 4 amp at sea level and 4 amp at 50,000 ft; maximum inrush, 15 amp. Micro Switch, Freeport, Ill.

For more information—
Circle 65, inside back cover



Subminiature Pushbutton Switches

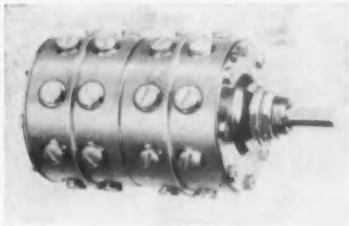
These switches are $\frac{3}{8}$ in. dia and extend behind the panel 0.592 in. Rated at 115 v, ac, and 100 milliamp in a resistive load, life expectancy is said to be over 300,000 operations. Available immediately in a normally open, momentary contact version. Grayhill, 561 Hillgrove Ave., LaGrange, Ill.

For more information—
Circle 66, inside back cover

Extra Heavy Duty Rotary Switch

This switch's operating principle involves the use of a spring-loaded, spring-actuated roller contact which seats in a stationary contact groove. Additional spring pressure and mechanical linkage force the roller from

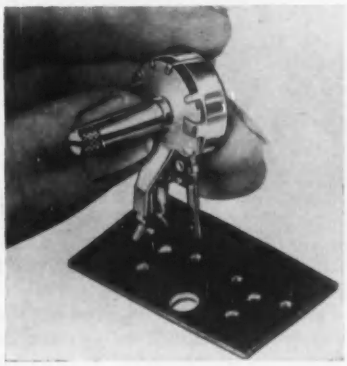
(Continued on page 293)



the contact groove with high acceleration, causing a lightning-fast break and driving the roller at high speed to the next contact. The high pressure and high speed of the roller result in minimum arc. And since the arc occurs away from the static position, switch life and capacity are greatly increased. This switch permits great flexibility in circuit design. It may be ganged up to three sections, allowing as many as 24 separate isolated circuits. It has a snap feel, low-contact voltage drop, and high capacity.

Continuous duty rating is 60 amp, max. Overload tested to 75 amp. Unit is rated at 35 amp, inductive, at 28 v, dc. Weight: 6.5 oz for basic wafer; additional wafers 5 oz each. Mason Electric Corp., 3839 Verdugo Road, Los Angeles, Calif.

For more information—
Circle 67, inside back cover



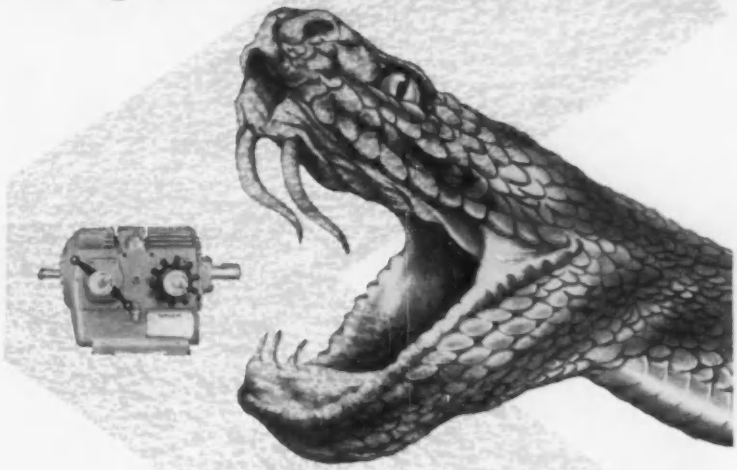
Snap-in Control for Printed Circuits

A self-supporting, snap-in variable resistor for printed wiring measures 57/64 in. dia, and stands $\frac{7}{8}$ in. off the mounting board.

The shaft is firmly supported by a 3/32 in. extruded bushing, and may be left round or equipped with flat, screwdriver slot, split knurl, diamond or straight knurl, or tongue. The unit

(Continued on page 296)

We wore out 110,000 Rattlesnakes



Have you ever been awed by the rapidity with which a rattler strikes and recoils? You should be! Old "diamond-back" can lash out and reverse himself in about 1/10th of a second. There's one catch—he wears out after a second or so of continuous activity.

Rapid Reversing

can be fatiguing for machinery as well as rattlesnakes, but . . . for the record, we reversed a GEROTOR VARIABLE SPEED HYDRAULIC TRANSMISSION (under load) over a million times—continuously at a rate of 22 times per minute—without the slightest sign of wear to the Gerotor Transmission.

If your operation demands rapid reversing, infinitely variable speeds, constant or variable torque and horsepower—all with positive overload protection—check on the new GEROTOR VARIABLE SPEED HYDRAULIC TRANSMISSION. *Write:*

GEROTOR
MAY CORPORATION
MANUFACTURERS OF—
1511 MARYLAND AVENUE, BALTIMORE 3, MARYLAND

EXON: each resin engineered for a specific problem

EXON 654

specifically for

Plastisols

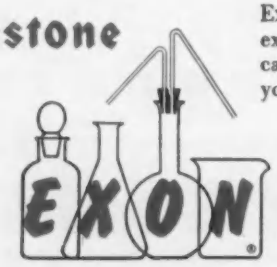
No grinding needed when you use Firestone plastisol resin. An extremely fine powder with high molecular weight, EXON 654 readily disperses in plasticizer with simple stirring equipment.

EXON 654 is expressly created to impart excellent heat and light stability, physical toughness and chemical stability to your products.

Pastes formulated from EXON 654 show exceptional viscosity stability and flow properties. Unsurpassed for processing ease and efficacy in coating fabric and paper, they endow these products with unusual tear and wear resistance.

Whatever your particular problem, you're likely to find the specific remedy in one of the many EXON resins.

Firestone



For complete information or technical service on the entire line of EXON *resins, call or write today.*

CHEMICAL SALES DIVISION

FIRESTONE PLASTICS COMPANY, POTTSTOWN, PA., DEPT. 66F

DIVISION OF FIRESTONE TIRE & RUBBER CO.

New trends and developments in designing electrical products . . .

Why General Electric Magnets clad in die-cast aluminum sheaths offer important design and cost advantages over the conventional methods of fabricating magnetic assemblies

THE MAN in the picture below is removing a section of a radar magnetron tube magnet from a piece of equipment that goes by the imposing title of "Lester-Phoenix Horizontal Cold Chamber H-HP-3X 400-Ton Die-Casting Machine."

This machine is in our Edmore, Michigan, magnet plant, and its sole function is to cast aluminum sheaths on General Electric Alnico Permanent Magnets.

These alclad magnets offer designers seven major advantages over conventional methods of fabricating magnetic assemblies.

1. Die casting strengthens the magnet structurally.
2. Whole assemblies can be designed and built as a single "package," speeding the final assembly job at the plant.
3. Design of mounting arrangements is simplified because pins, holes, and screws can be cast into the sheath, instead of the magnet.
4. Responsibility for the entire assembly is centered in a single source, simplifying purchasing procedures, and eliminating costly in-plant assembly operations.
5. Complete magnetic assemblies can be purchased premagnetized and/or pretested.
6. Die casting provides a consistent, more attractive finish for applications where appearance is important.
7. Die casting is a convenient, low-cost mass-production technique for magnetic assemblies that eliminates the problem of attaching crystalline cast magnets to other components.

The following examples will illustrate how these advantages can be turned to practical use.

Figure 1 is a relay drag magnet assembly, typical of those used in the meter and instrument industry. Before the manufacturer switched to this casting, it was necessary to cast a magnet against a piece of steel, bend the steel into the proper shape, and weld the ends together.

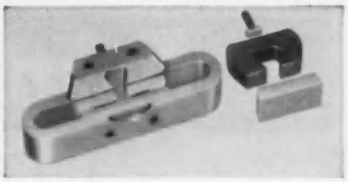


Figure 1

Now, however, magnet, mounting pin, and steel return path are assembled in a single operation – eliminating the difficult 3-stage fabrication job. This assembly – one of the most complex handled by the die-casting machine – illustrates the equipment's tremendous versatility.

Figure 2 is a generator rotor, consisting of eight G-E Alnico magnets held in position on a camshaft by the cast-aluminum matrix.

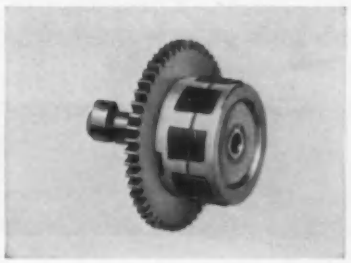


Figure 2

The casting supplements the strength of the magnets (which are subjected to high rotary speeds). And it eliminates difficult grinding, assembly, and banding operations.

The four radar magnetron tube magnets in Figure 3 give some idea of the wide range of sizes the machine is capable of handling. The smallest magnet (bottom, right) weighs only 1 lb., while a quarter section of the largest magnet weighs more than 11 lbs.

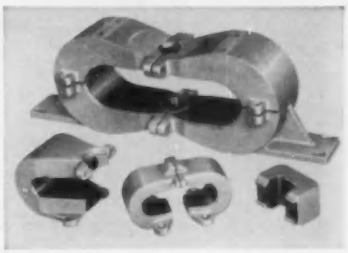


Figure 3

Here, the aluminum sheath improves magnetic stability by preventing direct contact between magnet surfaces and steel objects. In addition, the mounting brackets cast in the sheaths eliminate inserts normally cast in the magnets which would weaken its energy and structure.

Aluminum-sheathed magnets are often far less expensive than conventional magnets . . . especially on long production runs. And, in many of the cases where the unit cost of alclad magnets is higher, the tremendous advantages gained by die casting have more than offset the price difference.

The one best way to find out whether or not die casting is feasible on your application, is to check with a General Electric Magnet Engineer.

You can do this – or obtain information on any other problem in the realm of permanent magnets – by dropping a note to: *Carboloy Department of General Electric Company, 11127 E. 8 Mile Street, Detroit 32, Michigan.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

60 CALIBER LINKS FOR THE HIGHEST CALIBER PRODUCTION!

Stations by the dozens . . . tolerances to the ten thousandths . . . production in the millions . . . with progressive dies by

B. Jahn

60 caliber single and double loop links . . . produced by the millions — and hundreds of millions — and all must be absolutely identical, accurate! These stringent specifications demand the finest dies and diemakers — that's why B. Jahn was selected. The master toolmakers and engineers at B. Jahn built a 13 station and 16 station progressive die that formed the intricate components from heavy SAE — 1055 steel. Million plus runs . . . precise fidelity . . . and lasting economy . . . were engineered into every die — and verified by "production proving" in the B. Jahn plant before delivery. Whatever your product, your problem — B. Jahn die making ingenuity can help you deliver better goods . . . in less time . . . at less cost.

Die ribbons showing 13 and 16 stations necessary in producing tremendous runs of shell loop links!

NOW AVAILABLE! The brand new B. Jahn brochure—lavishly illustrated—colorful—fact-packed! Send for your copy today!

B. Jahn

THE B. JAHN MANUFACTURING COMPANY, NEW BRITAIN, CONNECTICUT

is rated at 0.75 w for values above 10,000 ohm, and 0.50 w below 10,000 ohm. Stackpole Carbon Co., St. Marys, Pa.

For more information— Cicle 68, inside back cover

Rubber-Cushioned Ball Bearings

These bearings were designed to replace ordinary sleeve bearings in home and commercial heating and air conditioning equipment where quiet operation is of primary importance. Through a combination of specially processed ball bearings encased in rubber, these units are said to reduce the sound of moving parts in such equipment. The line includes pillow block units and rubber cylindrical cartridges. Fafnir Bearing Co., New Britain, Conn.

For more information— Circle 69, inside back cover

Magnetic Bin Vibrators

A powerful permanent magnetic unit, together with an electro-magnet operating on ac, provides a vibrator which operates at 3600 vibrations per min. These need no rectifiers. They are said to transmit a rhythmic action to bins, hoppers or chutes handling dry materials in lump or powdered form, assuring a free and dependably even flow at all times. This action is reported to prevent sticking, arching or bridging of materials, while actually imparting a pulsating directional thrust. Two models of the vibrators are available: Model EU-20, designed for bins of 7 cu ft capacity and up to 1/16 in. thickness of bin wall; Model EU-30, designed for bins of 20 cu ft capacity and up to 3/16 in. thickness of bin wall. Since no rectifier is

(Continued on page 301)

a combination . . . for game!

laminated plastics . . . a combination of properties for trouble-shy designers

When a man goes a-hunting for a material for a specific application, he wants one that satisfies his own combination of property requirements . . . *and is easy to machine.* Synthane laminated plastic is just the material—*plenty* of good mechanical, electrical, electronic and chemical properties . . . combined with excellent machining and fabricating characteristics.

Synthane terminal insulators must meet high property and machining standards. They must have high dielectric strength in a machinable insulator, good moisture resistance, excellent arc resistance, good heat resistance and mechanical strength. This insulator and similar parts can be fabricated at the Synthane plant with no waste, no problems to the purchaser.

DIELECTRIC STRENGTH

HIGH STRENGTH-TO-WEIGHT RATIO

EASILY MACHINED

DIMENSIONAL STABILITY

. . . send for complete catalog and fabricating data.

SYNTHANE

SYNTHANE CORPORATION, 4 RIVER ROAD, OAKS, PA.

GENERAL ELECTRIC ANNOUNCES . . .

NEW Industrial

Direct-current Motor

KINAMATIC* a new standard in direct-current motors, gives your machines wider speed ranges, greater output

To meet modern industrial needs for faster, more automatic, more continuous production, General Electric has designed an entirely new direct-current motor—the d-c Kinamatic.

Designed for Automation—Now, a direct-current motor has been designed for the modern job it has to do—either as individual motor drive or in regulating systems. The new General Electric d-c Kinamatic motor supplies the wide speed range and versatility required for today's manufacturing methods. It is designed for the close control of machines and split-second timing of processes essential to higher output.

Accelerated Production—The new d-c Kinamatic motor will modernize your equipment, give it increased power, higher speeds, greater output capacity. With the quick-acting G-E Kinamatic motor, your machines will process a greater variety of products . . . faster . . . easier . . . and with less maintenance and spoilage.

More Powerful—By combining advanced design with improved materials and manufacturing techniques, General Electric engineers have packed more power into the entire Kinamatic line. The powerful Kinamatic motor, with new stamina and durability, is ready to become one of your most effective weapons for keeping costs down, for meeting competition, for boosting productivity levels.

Engineering Help—Industrial specialists in 149 conveniently located General Electric Apparatus Sales Offices have the complete story on how the new d-c Kinamatic motors and generators can benefit your operation. For full details, contact your G-E Sales Representative, or write for Bulletin GEA-6355. *Direct Current Motor and Generator Department, General Electric Company, Erie, Pennsylvania.* 813-1

* Trade Mark of the General Electric Company

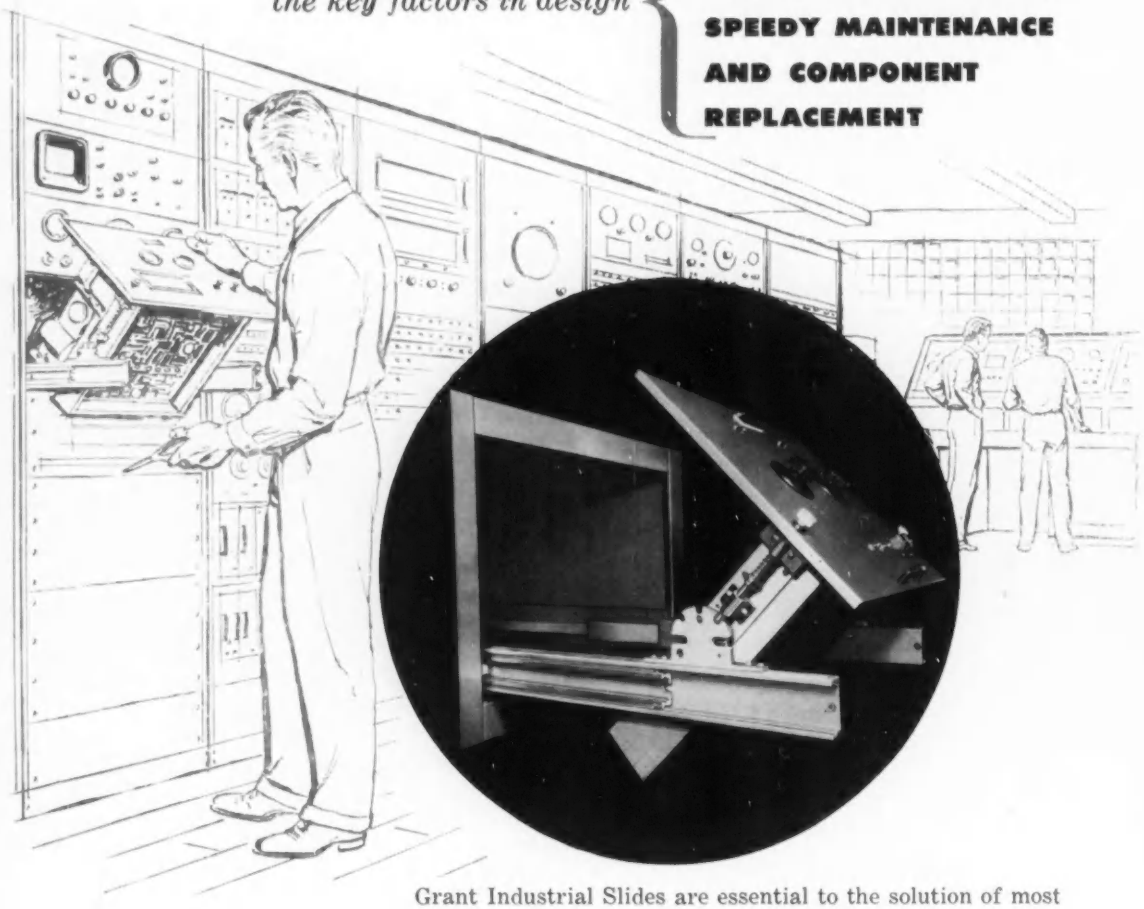
Progress Is Our Most Important Product

GENERAL ELECTRIC

Grant INDUSTRIAL SLIDES FOR

the key factors in design

ACCESSIBILITY
COMPACTNESS
PROVISION FOR EASY, SPEEDY MAINTENANCE AND COMPONENT REPLACEMENT



Grant Industrial Slides are essential to the solution of most problems centering on these design factors—so highly emphasized in this automation era. Grant Slides provide skillfully developed, competently engineered sliding, pivoting mountings for nearly all types of assemblies—electronic, hydraulic, pneumatic, mechanical.

Grant engineers and representatives are located in all important industrial centers—their valuable store of specialized experience is yours for the asking.

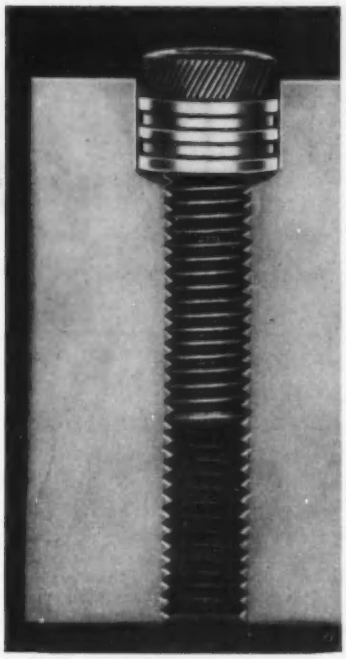
More Than 100 Pages of Important Working Data

The Grant Industrial Slide Catalogue—on the press—outlines principles, details, of more than 100 standard and custom-made slides. A working manual on built-in accessibility. Ask us to reserve your free copy.

Grant INDUSTRIAL SLIDES
Grant Pulley and Hardware Corporation
31-85 Whitestone Parkway, Flushing 54, N. Y.
944 Long Beach Avenue, Los Angeles 21, California

needed to convert from ac to dc, installation is completed by simply connecting the unit to the available current. Units are available in 115 or 230 v models. Eriez Mfg. Co., Erie 6, Pa.

For more information—
Circle 70, inside back cover

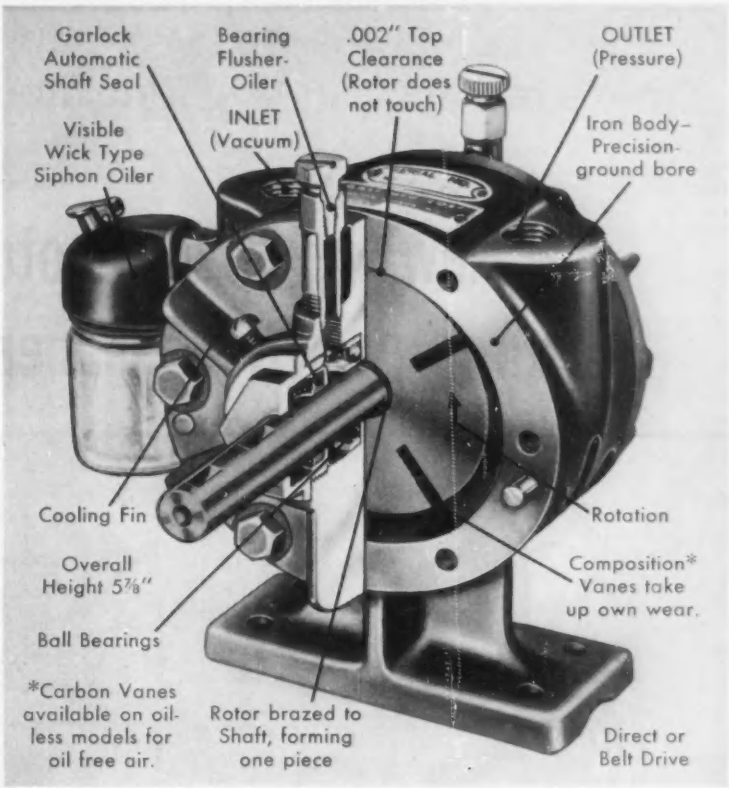


Vibration-Resistant Socket Screw

This fastening is manufactured in a line of socket shoulder screws (stripper bolts) and flat head socket screws as well as cap screws. It fits standard counterbores and oversized counterbores as well.

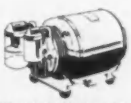
After being drawn hand-tight, the

(Continued on page 304)

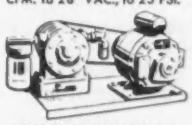

Garlock Automatic Shaft Seal
Bearing Flusher-Oiler
.002" Top Clearance (Rotor does not touch)
OUTLET (Pressure)
INLET (Vacuum)
Visible Wick Type Siphon Oiler
Iron Body–Precision-ground bore
Cooling Fin
Rotation
Overall Height 5⅞"
Composition* Vanes take up own wear.
Ball Bearings
*Carbon Vanes available on oil-less models for oil free air.
Rotor brazed to Shaft, forming one piece
Direct or Belt Drive

rotary vane

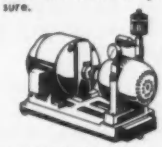
Quality and simplicity keep GAST AIR PUMPS operating for years at high efficiency levels



INTEGRAL-MOTOR PUMPS 1/12 to 1/3 H.P. .6 to 4 CFM. to 28" VAC., to 25 PSI.



LIGHT-DUTY PUMPS, V-belt or direct drive. 2 to 24 CFM. Moderate vacuum or pressure.



HEAVY-DUTY PUMPS, 1/4 to 1-1/2 H.P. 4 to 21 CFM. To 28" VAC. or 30 PSI. Cooling fans and fins.

As original components—or for special plant use—Gast Air Pumps offer important advantages. This cutaway reveals many reasons why they are specified as "original equipment" by more and more leading manufacturers.

All models are built to high quality-precision standards in a new, modern plant. All embody this inherently efficient, simple rotary-vane design. Balanced rotor is free of vibration. Sliding vanes are light in weight—for minimum motion-energy-friction loss compared to other pump designs. As vanes take up their own wear automatically, pump delivers full performance through years of use.

Get full details—write for *"Application Ideas" Booklet and Catalog.* Many sizes—*mention capacity and type that interests you!* **Gast Manufacturing Corp.,** P. O. Box 117-V, Benton Harbor, Michigan.

Original Equipment Manufacturers for Over 25 Years

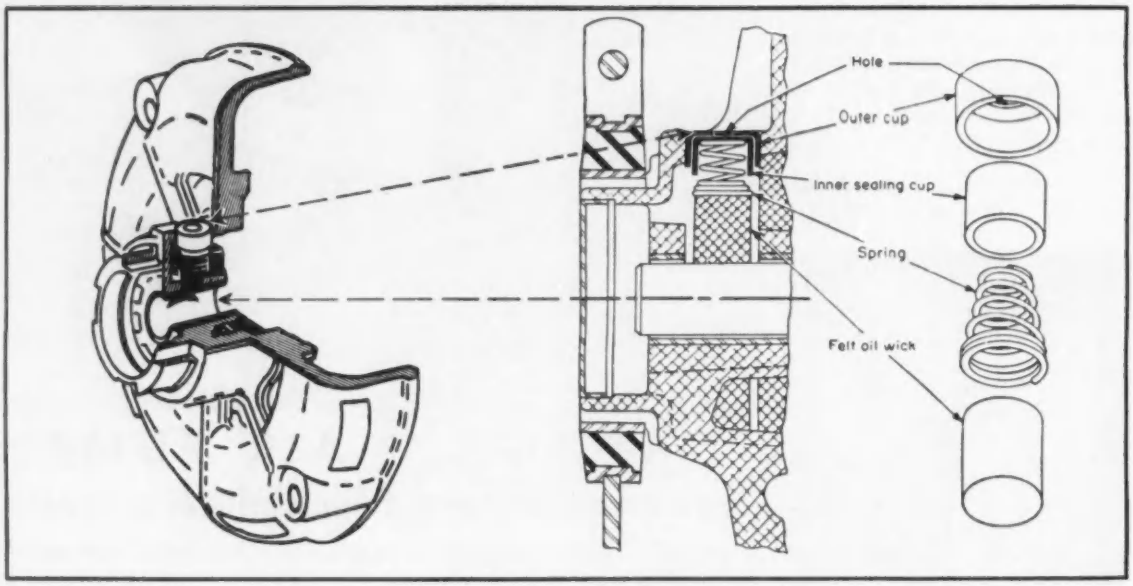
GAST ROTARY

- **AIR MOTORS** TO 4 H.P.
- **COMPRESSORS** TO 30 P.S.I.
- **VACUUM PUMPS** TO 28 IN.

SEE OUR CATALOG IN SWEET'S PRODUCT DESIGN FILE

Emerson-Electric engineering highlights

New, improved motor oiler assures positive, cleaner lubrication



A new-style oiler is a special feature included on many Emerson-Electric die-cast end-shield motors. It assures positive internal lubricating—also provides an added convenience in motor lubrication.

As shown in the illustration, the new oiler consists of three basic components—spring, retaining cup and oil-well cap. The spring performs two important functions:

First, it presses against a felt tongue which is part of the felt packing in the oil reservoir—the tongue extends through an opening in the sleeve bearing and makes direct contact with the shaft. By maintaining pressure against the tongue, proper lubrication is assured under all operating conditions.

Second, the spring holds the retaining cup in place against the oil-well cap; this prevents dirt and foreign matter from entering through the opening in the cap.

In addition, lubrication is simplified since pressure easily depresses the retaining cup, permitting oil to flow readily into the felt packing.

This is another of many Emerson Electric "highlight" engineering features that benefit designers and manufacturers of motor-driven appliances.

Call on Emerson-Electric motor-drive specialists

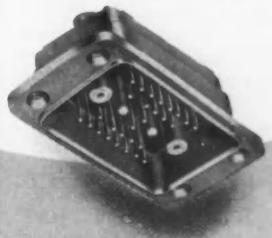
Recognized as a leader in equipment-drive motors for more than 60 years, Emerson-Electric specialists offer wide experience in all phases of motor-driven applications. You'll find their help valuable, whether you're designing or re-designing for performance and sales. Write for bulletin M-30. THE EMERSON ELECTRIC MFG. CO., ST. LOUIS 21, MISSOURI.

Emerson-Electric of St. Louis • Since 1890

BRANCHES: NEW YORK 7, N. Y., 11 Park Place • CHICAGO 23, ILL., 1623 S. Pulaski Road • SYRACUSE, N. Y., 209 Oakley Drive
PHILADELPHIA (Secane), PA., 868 Quince Lane • DETROIT 7, MICH., 1375 E. Jefferson Ave. • CLEVELAND 16, OHIO, 1580 Rockland Ave.
LOS ANGELES 42, CALIF., 5415 York Blvd. • DAVENPORT, IOWA, 617 Brady Street • CINCINNATI 11, OHIO, 2917 Ratterman Ave.

"A connector for practically every application"
... that's why Cannon Electric is *first in connectors.*
More than 26 lines in 20,000 different assemblies and countless
"specials." Only a pioneer multi-contact connector
manufacturer and the largest exclusive connector
designer and builder in the world could make this claim.

Mil-Spec



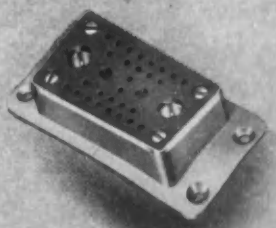
Rack/Panel/Chassis

Audio

THREE OF TWENTY-SIX SERIES

cannon connects

Mil-Spec



Rack/Panel/Chassis

Audio

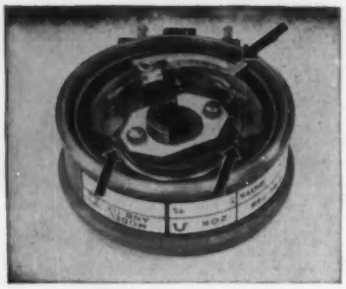
FIREPROOF • MINIATURE • MIL SPEC • EXTERNAL POWER
AUDIO • HERMETIC SEAL • RACK/PANEL/CHASSIS • WEATHERPROOF
WATERTIGHT • VIDEO • COAXIALS • HIGH VOLTAGE
SWITCHING PLUGS • TEST JACKS

CANNON PLUGS

CANNON ELECTRIC

Please Refer to Dept. 106

Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif. Factories in Los Angeles; East Haven; Toronto, Can.; London, Eng.; Melbourne, Australia. Licensees in Paris, France; Tokyo, Japan. Representatives and distributors in all principal cities...see your Telephone Yellow Book.



Arrows point to Paliney #7 contacts used in this Fairchild Type 746 Precision Potentiometer.

NEY'S small parts play a BIG part in precision instruments

Reliability of many precision electrical instruments depends upon accurate transmission of electrical signals between moving parts. The Potentiometer Division of the Fairchild Camera and Instrument Corporation has selected Ney Paliney #7* for use as wipers and sliders in their precision potentiometers because Paliney #7 provides the important advantages of a long life with excellent linearity and the ability to hold noise at a minimum.

Ney manufactures many other precious metal alloys which, like Paliney #7, have ideal electrical characteristics, high resistance to tarnish, and are unaffected by most industrial atmospheres. Ney Precious Metal Alloys have been fabricated into slip rings, wipers, brushes, commutator segments, contacts, and intricate component parts and are used in high precision instruments throughout industry. Should you have a contact problem, a call to the Ney Engineering Department will result in study and recommendations which will improve the output of your electrical or electronic instruments.

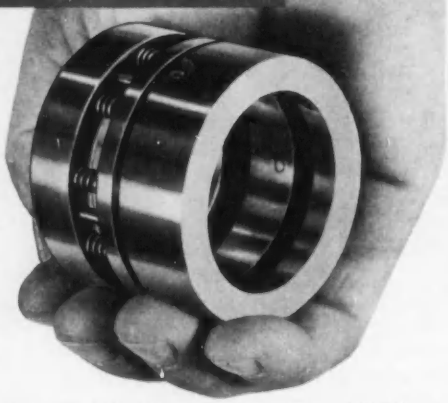
THE J. M. NEY COMPANY • 109 ELM ST., HARTFORD 1, CONN.

Specialists in Precious Metal Metallurgy Since 1812

*Registered Trade Mark

9NY55B

The Answer to Your *SEALING PROBLEMS* in the Palm of Your Hand



DURA SEAL

. . . an engineered rotary mechanical seal that is made to meet YOUR SPECIFIC SEALING NEED using selected alloys, carbons and ceramics.

In general, Dura Seals can be installed on new or existing equipment—no sleeves or special machining necessary.

Write Today FOR DETAILS — ASK FOR BULLETIN NO. 455-PG

Send your sealing problems to us for free counsel

DURAMETALLIC CORPORATION

KALAMAZOO MICHIGAN

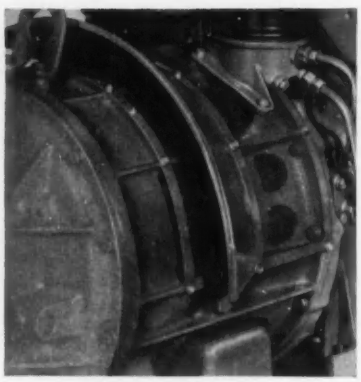
screw is tightened with a key, causing the expansion insert (bronze, aluminum, steel) to spread and fill the cavity. The insert stays in place whenever the screw is removed and is said not to lose its effectiveness when the screw is reinserted. Safety Socket Screw Co., 6501 N. Avondale Ave., Chicago 31, Ill.

For more information— Circle 71, inside back cover

Subminiature Trimmer Potentiometer

This wire-wound potentiometer provides an independent linearity of ±5 per cent, standard, and a ±10 per cent standard accuracy of total resistance. Low temperature coefficient of the resistance wire (0.0017 per cent per deg C) contributes to the high electrical stability of the unit over a wide temperature range. Standard temperature range is from −55 C to 95 C. Power rating for this diminutive trimmer is ½ w at 30 C, derated linearly to 0.05 w at 95 C for standard units. A wide range of standard resistance values are available from 50 to 15,000 ohm. Technology Instrument Corp., 531 Main St., Acton, Mass.

For more information— Circle 72, inside back cover



Industrial Torque Converter

This torque converter is lightweight, due to its cast aluminum construction. Coupling efficiency is handled automatically, and when torque demand falls off due to load diminishing, converter enters coupling range where it

(Continued on page 307)

DOW CORNING CORPORATION

Silicone News

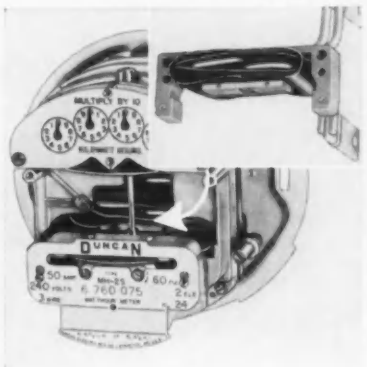
FOR DESIGN ENGINEERS No. 25

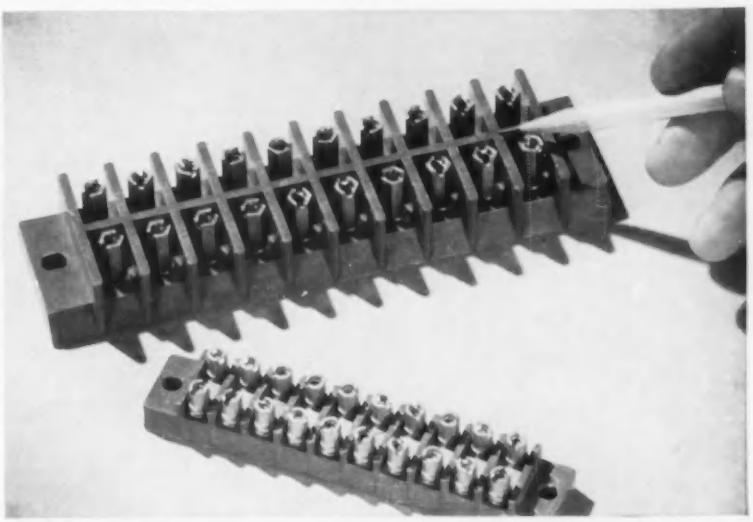
Current Meters Have 400% More Capacity With Silastic Insulation

With power requirements of the average household doubling every eight to ten years, Duncan Electric Manufacturing Company, Lafayette, Indiana, exercised considerable foresight in developing 50-amp socket-type watthour and demand meters that can handle continuous loads as high as 200 amperes. Duncan designers utilized the dielectric and physical properties of Silastic,* Dow Corning's silicone rubber, in engineering 4 times more capacity into a standard size meter.

The copper specified for the current coil of the new meter is considerably larger than that normally used. This means that the space available for the current coil insulators—a set of rubber belts known as "britches insulation"—is, in Duncan's words, . . . "limited and, therefore the insulation must be of the very best type."

(cont'd. pg. 2)





Molded Silicone Compound Has High Resistance To Heat, Moisture and Dielectric Breakdown

Superior retention of physical and dielectric properties at high temperatures plus low moisture absorption, in stud-barrier terminal boards molded of Dow Corning 301 Molding Compound, proved in tests by leading airframe manufacturer.

After 4 years of experience in molding 34 different types and kinds of terminal boards to meet Specification MIL-P-14D, General Products Corporation of Union Springs, N. Y., selected the asbestos-phenolic combination, Navy Code MFI-20, as the best material for comparison with test boards molded of Dow Corning 301 Compound.

Navy-type terminal board molded of 301 Compound was exposed to a potential of 5,500 volts at room temperatures before an arc was drawn between terminals. General Products estimates a breakdown voltage in the range of 3,500 for MFI-20 terminal board.

Resistance to dielectric breakdown between terminals of the 301 molded board dropped to 2,800 volts at high temperatures because of the lower resistance of the ambient air. Resistance to break down remained constant, however, at 2,800 volts after an hour at 550 F. Under similar conditions MFI-20 types terminal panels break down within 10 minutes.

Moisture absorption after 18 hours at 100% relative humidity was 0.06% for terminal boards molded of 301 compound compared with 0.6% for the phenolic-asbestos combination.

Other samples molded of 301 compound were heated for 30 minutes at temperatures progressively increased by 50 F until a temperature of 940 F was reached. That's 600 degrees above the serviceable limits of

(cont'd. pg. 2)

Silicones Improve Outboard Motor "Bail-a-matic" Pump

Scott-Atwater's new 30 hp outboard motor helps keep the boat dry by driving a built-in positive displacement pump. This "Bail-a-matic" pump is comprised of two tight-fitting rubber impellers within a die-cast aluminum housing lined with stainless steel. Although skillfully engineered the pump tended to seize after a winter's inactivity.

The problem was quickly eliminated however, by the application of a few drops of Dow Corning 200 Fluid to the impellers during assembly. Today 200 Silicone Fluid, with its good lubricity for rubber and inherent temperature stability, is specified to keep all "Bail-a-matic" pumps operational regardless of long inactivity and broad temperature variations. **No. 248**

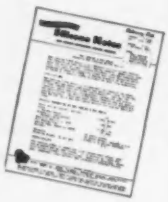
FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE

DOW CORNING CORPORATION

Silicone News

DOW CORNING PUBLICATIONS ON NEW DEVELOPMENTS AND TECHNICAL DATA . . . .



"Effects of Radiation on Organopolysiloxanes," a research paper reprinted from Industrial and Engineering Chemistry, describes the effects of secondary radiation from 4 different sources on organopolysiloxanes. Sources include cyclotron radiation, cobalt —60 gamma, electron, and X-ray. Results indicate that siloxanes containing large amounts of phenyl substitutions may be good construction materials around high energy radiation units. *No. 252*

Now available—1956 Reference Guide to Dow Corning Silicone Products. A concise, comprehensive, 12 page reference that is convenient-to-use. It's packed with data, properties, and information on how you can use silicones in designing new equipment, improving performance and reliability of original equipment, or reducing production and maintenance costs. *No. 253*

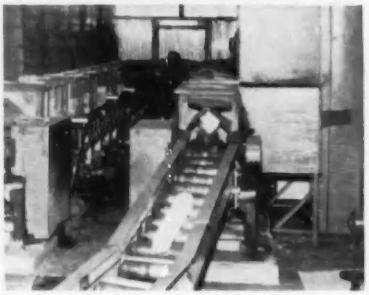
"What's a Silicone?" is the title of a 32-page booklet which answers that often asked question in semi-technical terms. Indexed and illustrated, this booklet has earned an international reputation as the most interesting and informative description of silicones ever published. *No. 254*

Producers of structural laminates will want to try heat-cleaned glass cloth finished with Dow Corning T-31. Effective with epoxy, phenolic, polyester and silicone resins, this new finish enables laminators to meet most specifications with one type of finished glass cloth. Easy to apply with conventional equipment, T-31 requires no buffering before application; no washing, neutralizing or curing after application. For more information circle ---------- *No. 255*

New booklet on Silicone Based Paints describes and illustrates how these heat, moisture, weather and oxidation resistant coatings improve product finishing and reduce maintenance costs on equipment ranging from industrial furnaces and exhaust stacks to domestic space heaters and garbage incinerators. Also explains differences between the straight silicone and modified silicone paints now available from more than 50 formulators listed as sources of supply. *No. 256*

Rolling Mill Production Increased 30% With Silicone Insulated Heating Coils

By using coils insulated with Dow Corning Silicones in their induction heating furnaces Vancouver Rolling Mills of Canada has cut steel ingot heating time 75%; reduced fuel costs $200 per day. And even more important to a steel-hungry economy, production has been increased 30%.



Designed and constructed by General Engineering Ltd., Toronto, this is the largest induction heating installation in the world. Indications are that the design techniques including the silicone insulated coils may well revolutionize the reheating of steel ingots or billets wherever electric power is in good supply.

Two coil "tunnels" are divided into two stages. In the first stage almost half of the required 7000 KW is applied at 60 cycles, heating cold ingots to 1400 F. The second stage, at 540 cycles, brings ingot temperature up to 2300 F. To demonstrate the efficiency of the system, a cold ingot can become bar stock within 10 minutes after entering the furnace. Rated production is 20 tons an hour.

Insulated with Dow Corning Silicones, the coils are frequently within inches of the white-hot ingots. On occasions when sections of the refractory material serving as thermal insulation have been broken away, the silicone insulation has been exposed to greatly elevated temperatures without failure. The unit has been in operation since July, 1954. *No. 251*

CLASS H MOTOR STILL ON TEST AFTER 55,367 HOURS AT 240 C

At 10 A.M., June 6, 1946, a Class H insulated 5 hp motor was generator loaded to operate at its test temperature of 240 C in Dow Corning's motor test labs. Every 500 hours since it has been shut down and exposed to 100% relative humidity for 24 hours. As of 11 A.M. March 1, 1956, this motor was still on test after 55,367 hours at an average copper temperature of 240 C! That's equivalent to 336.5 years operation at the Class H temperature of 180 C.

MOLDED SILICONE *(continued)*

MFI-20 types materials. Even though fine grain cracks started to appear at 600 F and became more pronounced at higher temperatures, the silicone terminal boards retained good dielectric properties.

In spite of higher initial costs, General Products feels that superior performance makes 301 Molding Compound the most economical materials available for the steadily increasing number of extreme service applications confronting electronic and ordnance designers. *No. 249*

SILASTIC INSULATORS *(continued)*

It must resist surges caused by lightning and withstand maximum loads for long periods of time without deterioration. The insulation must also have enough physical strength to prevent damage during shipment or installation, and be completely resistant to cold flow. Moreover, it must retain its dielectric and physical properties for the full life of the meter, usually about 30 years.

To meet these rigid requirements Duncan specifies current coil insulators fabricated from Silastic. *No. 250*

*TM REG. U.S. PAT. OFF.

Dow Corning Corporation, Dept. 8604, Midland, Michigan

Please send me: 248 249 250 251 252 253 254 255 256

NAME _____

TITLE _____

COMPANY _____

STREET _____

CITY _____ ZONE ____ STATE _____

SILICONE NEWS is published for product design and development engineers by

DOW CORNING MIDLAND — *first in silicones* — DOW CORNING SILICONES — CORPORATION MICHIGAN

ATLANTA CHICAGO CLEVELAND DALLAS DETROIT LOS ANGELES NEW YORK WASHINGTON, D.C. (SILVER SPRING, MD.)

CANADA: DOW CORNING SILICONES LTD., TORONTO GREAT BRITAIN: MIDLAND SILICONES LTD., LONDON FRANCE: ST. GOBAIN, PARIS

is reported to reach almost 97 per cent efficiency. The converter provides torque multiplication of 2.6. Industrial Engine Div., Chrysler Corp., Detroit 31, Mich.

For more information—
Circle 73, inside back cover

Solderless Connectors

These terminals and connectors fit all crimping tools. Barrels are said to be ½ in. longer than usual, and to contain more V-type grooves for better support. Made of soft, pure copper, these connectors are tinned. Hollingsworth Co., Dept. A, Phoenixville, Pa.

For more information—
Circle 74, inside back cover

Magnetic Amplifier-Controlled Power Supply

These gas tube reference units operate from a 115 v, ±10 per cent, 400 cps, ±5 per cent, single-phase power source. Regulation is better than ±1 per cent from zero to full load current, with ±10 per cent line variations. Drift of nominal output voltage over an ambient temperature range of −40 C to 65 C is within 1 per cent. Maximum rms ripple voltage is 0.2 per cent of nominal d-c output voltage. Saratoga Industries, Saratoga Springs, N. Y.

For more information—
Circle 75, inside back cover

Reversible Decade Counter

In a package said to be no larger than "one-way" counters, this reversible unit can be electronically or manually controlled continuously, by either an external flip-flop or d-c volt-

(Continued on page 308)

20 years of

OUTSTANDING PERFORMANCE

Have made Durakool Tilt-Switches and Timer-Relays the Recognized Standard of Industry

Now celebrating its 20th year, Durakool, Inc., is proud of the many records of achievement set by its mercury tilt-switches and timer relays.
The basic "Sealed under pressurized hydrogen" principle has been proved on thousands of applications. So successful have they been that they are now the accepted standard of the industry:

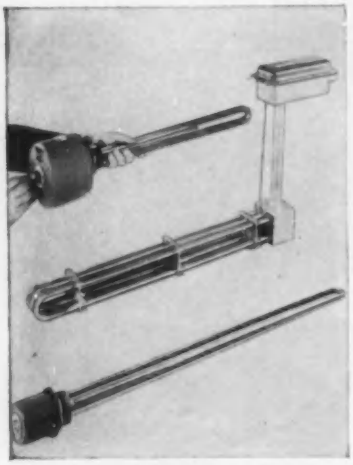
- **Millions of contacts or cycles without faltering**
- **Outlasts the normal equipment life**
- **Trouble free under every practical temperature or humidity condition.**
- **The tougher the assignment, the more Durakools stand out.**

For detailed information about your exact application WRITE TODAY.

DURAKOOL, INC.
ELKHART, INDIANA, U. S. A. • 700 WESTON RD., TORONTO 9, CANADA

Durakool

VISIT OUR BOOTH NO. 520 AT THE DESIGN ENGINEERING SHOW PHILADELPHIA, MAY 14-17



CHROMALOX
Electric
IMMERSION HEATERS
with or without
built-in thermostats
. . . fit the heat to your need up to 100,000 watts and 2,500 psi

Full range of sizes and ratings in portable, screw-plug and flanged types. Available with copper, steel or alloy sheaths to resist corrosion.

Used for heating water, asphalt, greases, molten salts, pickling and plating baths, process kettles; for superheating steam and compressed air; for melting lead, solder, babbit; and for a wide range of similar applications.

Let the Chromalox Sales-Engineering staff solve your heating problems . . . electrically.

Write for your copy of Catalog 50

—for full information on the complete line of Chromalox Electric Heaters and controls.

For ideas on additional applications of electric heat, request Booklet F1550—"101 Ways to Apply Electric Heat."

Edwin L. Wiegand Company
7535 Thomas Boulevard, Pittsburgh 8, Pennsylvania

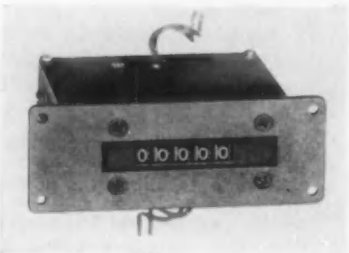
EDWIN L. WIEGAND COMPANY
7535 Thomas Boulevard, Pittsburgh 8, Pa.
I would like to have . . .
☐ a copy of Catalog 50
☐ a copy of "101 Ways"
☐ a Sales-Engineer contact me.

Name_____
Company_____
Street_____
City_____ Zone____ State_____
A-4467A

ages. Applications are expected to range from continuously tracking digital voltmeters and data converting devices to integrators and digital differential analyzers. The internal gating is a unique circuit employing reliable long-life neon bulbs. Readout is visual in binary coded decimal and electrical by a "staircase" voltage indicating the count. Decades can be cascaded to add or subtract any desired number of pulses.

Maximum continuous counting speed is 50,000 cps. Input requirement is negative pulse, 90 v peak. Dimensions: 1⅜ x 5½ x 6 in.; weight, 1 lb. Controller Instrument Co., 1612 Que St., N.W., Washington 9, D. C.

For more information—
Circle 76, inside back cover



Add-and-Subtract Counter

This model is designed for panel mounting and comes equipped with mounting plate. The entire assembly can be placed and fastened from the front. The unit is ideal for inventory control. It adds one on impulse from one contact switch, and subtracts on impulse from a second switch.

It is used in production record systems for immediate registration of stock reservation, withdrawals, or additions. It may also be used to indicate the number of pieces on a conveyor line at any time. The pieces

(Continued on page 313)

SERVO MOTORS
from FORD INSTRUMENT for EXTREMELY LOW INERTIA AND HIGH FREQUENCY RESPONSE

- **STANDARD SERVO MOTORS in nominal ratings of 10w, 5w, 2½w, 1½w and ½w**
- **SPECIALS to customer requirements.**

Ford Instrument's high precision servos are available in high and low voltage models, in 60cy and 400cy designs, for a multitude of applications. With Ford's smooth iron, low-inertia rotors, they offer these advantages:

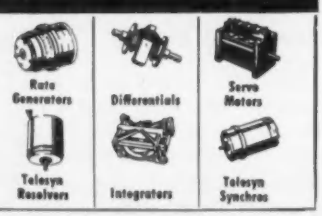
- Linear torque-voltage characteristic
- Linear torque-speed characteristics
- Withstand continuous stalling
- High torque efficiency

FREE—Fully illustrated data bulletin gives specifications and performance information.
Address Dept. PE

4BA

FORD INSTRUMENT COMPANY
Division of Sperry Rand Corporation
31-10 Thomson Ave.
Long Island City 1, N. Y.

Ford Instrument's standard components



(*Advertisement*)

DESIGNING WITH ALUMINUM

NO. 18

Note—This article contains completely up-to-date information. It replaces your old sheet No. 9.

This is one of a series of information sheets which discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series will be supplied on request. Address: Advertising Department, Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

PROPERTIES AND CHARACTERISTICS OF ALUMINUM CASTING ALLOYS

CHOOSING the proper aluminum casting alloy and heat-treatment requires a complete knowledge of the service conditions of the part under consideration. The alloys, heat treatments and various casting methods in common use must also be understood.

There are over thirty recognized casting alloys, with as many as five different heat-treatment possibilities for some. This results in a large number of choices from which to satisfy individual requirements. Because of these many alloy and heat-treatment combinations the possible range of typical mechanical properties varies widely.

Frequently, commercial castings do not have critical service requirements, and in such cases the foundryman should be consulted to ascertain the most economical alloy and production method which will do the job.

However, in most instances castings are designed for maximum efficiency, and in such cases, the alloy and heat treatment must be carefully selected from those available. In doing this, the designer, with his greater knowledge of the service requirements for the casting, must confine the choice of alloys to those which provide the necessary properties. He must then be guided by the foundryman in the final choice, as the alloy which looks best in the tables may have some production characteristics which would make it less desirable on an overall basis than other eligible alloys. The foundryman is in the best position to advise on such factors as availability, relative ingot costs, production costs and reproducibility of results. When this is coordinated with the designer's knowledge of service requirements such as strength, hardness, corrosion resistance, impact strength and machinability, the best possible selection will result.

As a result of this coordination, changes from initial design may be indicated which will improve design efficiency, or lower production costs, or both. For instance, a casting having sound design from every other standpoint may have a size or shape pointing to problems of distortion in heat treating which could be minimized through design changes.

Factors to Consider

The production and service requirements have a large bearing on the casting method, as do size and shape of part. For example, castings required in fairly large numbers, should be made either by permanent mold or die casting process, provided the size and design features of casting and available alloys are suitable.

The sand casting process is usually confined to producing parts required in small quantities, those having hollow cavities and complex arrangement of ribs, pockets, etc., and to those whose size makes them unsuited for casting in metal molds. In many cases it will be advantageous to redesign a part to make it adaptable for production by either permanent mold or die casting method. Sand casting usually requires minimum tooling charge, but unit price of castings and the finished part is high. Permanent molding and die casting involves higher tooling charge, but unit price is lower, particularly for longer runs. Die castings are the extreme, usually involving highest tooling charge and lowest piece price on large quantities.

Once the casting method is determined, the alloy choice is narrowed down appreciably.

Next to be considered are the service requirements. If high strength is necessary, that ordinarily eliminates the non-heat-treatable alloys when using an efficient design. This can be further and rapidly narrowed down when the remaining requirements such as leak tightness, corrosion resistance, machinability and others are considered.

In some instances, one certain property may be required to the maximum degree—for example, highest possible yield strength. This immediately narrows down the alloy and heat treatment choice as well as casting method to a possible one or two, and bigger compromises will have to be made for the other requirements, particularly ductility.

In other cases the large size and shape of a casting may not permit the use of a "solution heat-treatment," but will limit it to use of a "straight aging treatment" taking place in approximate temperature range of 300°F to 500°F, or to no treatment at all, thereby sacrificing, to a degree, some of the mechanical properties and slightly decreasing machinability.

The reason for this limitation is the fact that the first half of a solution heat-treatment takes place at a temperature ranging between 930°F to 1,000°F, followed by rapid quench in water. At those temperatures, the mechanical strength of aluminum is practically zero and therefore large unsupported areas of the casting, or the whole casting at times, may sag or distort from its own weight. Sometimes the size and shape of part are such that it can withstand the effects of the high temperatures but cannot be quenched without danger of warping or cracking.

Die castings are always used in the as-cast condition, which limits the choice to one of alloy selection only.

To assist the designer in becoming familiar with the various casting processes, mechanical properties, and physical properties we refer him to these tables on the following pages:

Table #1—Typical Mechanical Properties of Aluminum Sand Castings

Table #2—Typical Mechanical Properties of Aluminum Permanent Mold Castings

Table #3—Typical Mechanical Properties of Aluminum Die Castings

Table #4—Alloy Selection Guide

Sand casting, permanent mold casting, and die casting are the more widely used production methods. However, in special cases the part may be produced more efficiently by other methods such as shell molding, plaster molding, investment casting or centrifugal casting.

CONTINUED ON NEXT PAGE ➡

SAND CASTING ALLOYS—TABLE 1

Alloy	H. T.[3]	Typical Mechanical Properties[1]					Casting and Service Characteristics[2]						
		Tensile Strength psi	Yield Strength psi	Elongation Per Cent in 2"	Hardness Brinnell 10/500	Fatigue psi	Feeding Ability	Pressure Tightness	Hot-Shortness	General Castability	Machinability	Corrosion Resistance	Weldability[5]
43	AC	19,000	8,000	8.0	40	6,500	E	E	SL	E	F	VG	E
108	AC	21,000	14,000	2.5	55	8,000	VG	VG	MIN	VG	G	G	VG
122	T2	27,000	20,000	1.0	80	9,500	G	G	MOD	G	E	F	F
122	T61	41,000	40,000	(6)	115	8,500	G	G	MOD	G	E	F	F
142	T21	27,000	18,000	1.0	70	6,500	G	F	AP	F	VG	F	F
142	T571	32,000	28,000	.5	85	8,000	G	F	AP	F	VG	F	F
142	T77	28,000	25,000	2.0	75	9,500	G	F	AP	F	VG	F	F
195	T4[4]	32,000	16,000	8.5	60	6,000	G	G	AP	F	G	G	F
195	T6	36,000	24,000	5.0	75	6,500	G	G	AP	F	VG	G	F
195	T62	40,000	30,000	2.0	90	7,000	G	G	AP	F	E	G	F
212	AC	23,000	14,000	2.0	65	8,000	G	G	MOD	G	E	F	G
214	AC	25,000	12,000	9.0	50	5,500	F	F	MOD	F	E	E	G
B214	AC	20,000	13,000	2.0	50	.....	F	F	MOD	G	E	E	G
F214	AC	21,000	12,000	3.0	50	.....	F	F	MOD	F	E	E	G
220	T4	46,000	25,000	14.0	75	7,000	F	F	MOD	F	E	E	F
319	AC	27,000	18,000	2.0	70	10,000	E	E	SL	E	G	G	G
319	T6	36,000	24,000	2.0	80	10,000	E	E	SL	E	G	G	G
355	T51	28,000	23,000	1.5	65	7,000	E	E	SL	E	E	VG	VG
355	T6	35,000	25,000	2.5	80	8,500	E	E	SL	E	E	VG	VG
355	T61	39,000	35,000	1.0	90	.....	E	E	SL	E	E	VG	VG
355	T7	38,000	36,000	0.5	85	8,500	E	E	SL	E	E	VG	VG
355	T71	35,000	29,000	1.5	75	10,000	E	E	SL	E	G	VG	VG
356	T51	25,000	20,000	2.0	60	7,500	E	E	SL	E	G	E	VG
356	T6	33,000	24,000	4.0	70	8,000	E	E	SL	E	G	E	VG
356	T7	34,000	30,000	2.0	75	.....	E	E	SL	E	E	E	VG
356	T71	28,000	21,000	4.5	60	.....	E	E	SL	E	G	E	VG

NOTES:

1. Properties determined on standard tensile test bars cast under favorable conditions and properly heat-treated, when applicable.
2. Ratings: E, excellent; VG, very good; G, good; F, fair—apply to all castings and service characteristics except Hot-Shortness; AP, appreciable; MOD, moderate; MIN, minor; SL, slight.
3. AC, as cast.
4. On standing at room temperature for several weeks, properties approach those of T6 condition.
5. Weld before heat-treating, using appropriate filler rod.
6. Less than 0.5% elongation.

PERMANENT MOLD CASTING ALLOYS—TABLE 2

Alloy	H. T.[3]	Typical Mechanical Properties[1]					Casting and Service Characteristics[2]						
		Tensile Strength psi	Yield Strength psi	Elongation Per Cent in 2"	Hardness Brinnell 10/500	Fatigue psi	Feeding Ability	Pressure Tightness	Hot-Shortness	General Castability	Machinability	Corrosion Resistance	Weldability[5]
43	AC	23,000	9,000	10.0	45	.....	VG	E	SL	E	F	VG	E
A108	AC	28,000	16,000	2.0	70	.....	VG	VG	MIN	VG	G	G	VG
122	T52	35,000	31,000	1.0	100	.....	G	G	MOD	G	E	F	F
122	T551	37,000	35,000	.....	115	8,500	G	G	MOD	G	E	F	F
122	T65	48,000	36,000	.....	140	9,000	G	G	MOD	G	E	F	F
A132	T551	36,000	28,000	.5	105	13,500	G	VG	MIN	G	F	G	G
A132	T65	47,000	43,000	.5	125	.....	G	VG	MIN	G	F	G	G
D132	T5	36,000	28,000	1.0	105	13,500	VG	VG	MIN	VG	G	F	G
138	AC	30,000	24,000	1.5	100	.....	.....	G	MIN	F	G	.....	.....
142	T571	40,000	34,000	1.0	105	10,500	F	F	AP	F	VG	G	F
142	T61	47,000	42,000	.5	110	9,500	F	F	AP	F	VG	G	F
B195	T4[4]	37,000	19,000	9.0	75	9,500	G	G	MOD	G	G	G	G
B195	T6	40,000	26,000	5.0	90	10,000	G	G	MOD	G	G	G	G
B195	T7	39,000	20,000	4.5	80	9,000	G	G	MOD	G	G	G	G
A214	AC	27,000	16,000	7.0	60	.....	F	F	AP	F	E	E	G
319	AC	34,000	19,000	2.5	85	.....	E	E	SL	E	G	G	G
319	T6	40,000	27,000	3.0	95	.....	E	E	SL	E	G	G	G
355	T51	30,000	24,000	2.0	75	.....	E	E	SL	E	VG	VG	VG
355	T6	43,000	27,000	4.0	90	10,000	E	E	SL	E	VG	VG	VG
355	T62	45,000	40,000	1.5	105	10,000	E	E	SL	E	E	VG	VG
355	T7	40,000	30,000	2.0	85	10,000	E	E	SL	E	VG	VG	VG
355	T71	36,000	31,000	3.0	85	10,000	E	E	SL	E	VG	VG	VG
356	T6	40,000	27,000	5.0	90	13,000	E	E	SL	E	G	E	VG
356	T7	33,000	24,000	5.0	70	11,000	E	E	SL	E	G	E	VG
363	AC	35,000	23,000	2.7	85	.....	E	VG	SL	E	E	G	E
363	T6	48,000	28,000	6.5	90	.....	E	VG	SL	E	E	VG	E
750	T5	20,000	8,500	10.0	45	9,000	.....	.....	.....	.....	E	.....	.....

NOTES:

1. Properties determined on standard tensile test bars cast under favorable conditions and properly heat-treated, when applicable.
2. Ratings: E, excellent; VG, very good; G, good; F, fair—apply to all castings and service characteristics except Hot-Shortness; AP, appreciable; MOD, moderate; MIN, minor; SL, slight.
3. AC, as cast.
4. On standing at room temperature for several weeks, properties approach those of T6 condition.
5. Weld before heat-treating, using appropriate filler rod.

DIE CASTING ALLOYS—TABLE 3

Alloy	Condition[3]	Typical Mechanical Properties[1]					Casting and Service Characteristics[2]					
		Tensile Strength psi	Yield Strength psi	Elongation Per Cent in 2"	Hardness Brinnell 10/500	Fatigue psi	Mold Filling Capacity	Hot-Shortness	Die Solder Tendency	Machinability	Corrosion Resistance	Weldability
13	AC	39,000	21,000	2.0	.....	19,000	E	VL	E	F	VG	not
A 13	AC	35,000	16,000	3.5	.....	.....	VG	VL	VG	F	VG	recom-
43	AC	30,000	16,000	9.0	.....	17,000	G	MIN	F	F	VG	mended
218	AC	45,000	27,000	8.0	.....	23,000	F	AP	F	E	E	"
360	AC	44,000	27,000	3.0	.....	19,000	E	VL	G	F	G	"
A360[4]	AC	41,000	23,000	5.0	.....	18,000	E	VL	G	F	E	"
380	AC	45,000	26,000	2.0	.....	20,000	E	MOD	E	G	G	"
A380[4]	AC	46,000	25,000	3.0	.....	19,000	E	MOD	E	G	G	"
384	AC	46,000	27,000	1.0	.....	21,000	E	MOD	E	G	G	"

NOTES:

1. Properties determined from standard test bars cast under favorable conditions.
2. Ratings: E, excellent; VG, very good; F, fair—apply to all castings and service characteristics except "hot-shortness"; AP, MOD, MIN, VL apply to "hot-shortness" only.
3. As cast.
4. In A360 and A380, the iron content is controlled more closely than in 360 and 380 alloys.

SELECTION GUIDE—TABLE 4

Major Property Wanted	Sand Cast	Perm. Mold	Die Cast
General purpose—Low strength arranged in order of decreasing castability	43 108 212 214	43 A108 A214	13 A 13 43
General purpose—Heat-treated[1] good balance of all properties for most applications	355-T6 356-T6 319-T6 195-T6	355-T6 356-T6 319-T6 B195-T6	380 A380 360 A360
Best castability for complex castings with thin sections—arranged in order of decreasing castability	43 319 356 108 355	43 319 356 M108 355	A360; 360 A 13; 13 43
High ductility and shock resistance arranged in order of decreasing properties	220-T4 195-T4 214[2] 356-T6 319 43	A214 B195-T4 356-T6 363-T6 319 43	218 A360 43
Pressure tight—Low stressed	43 108 319	43 A108 319	A360 A 13 43
Pressure tight—High stressed	356 355 319	356 355 319 363	A360

Major Property Wanted	Sand Cast	Perm. Mold	Die Cast
Corrosion Resistance	43 214 220 356 355 319	43 A214 356 355 319 363	218 A360
Ornamental and Architectural Applications—also food handling, dairy equipment, cooking utensils and marine fittings	43 214[2] B214[2] F214[2]	43 A214[2]	43 218[2]
Piston Alloys—good properties at operating temperatures	122 142	122 A132 D132 142	384 85
Other alloys having good properties at moderate temperatures	214	138 A214	13 360
Good machinability—Heat-treated castings machine better than those in as-cast condition, and generally those having highest hardness machine better than the softer ones in any one alloy	122 212 214 B214 F214 220-T4 195 319	122 355 363 A214 A108 319	218 380 A380

NOTES:

1. Except die castings.
2. These alloys take anodized finish without appreciable discoloration.

More detailed assistance with design, alloy selection, fabrication, and heat-treatment procedure is obtainable through any Kaiser Aluminum sales office located in principal cities, or write to Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

Kaiser Aluminum

Setting the pace—in growth, quality and service

fed into the line add counts, while the pieces removed substract counts.

Overall dimensions are: 4⅞ x 1⅝ x 2⅝ in. deep. Operating speed is up to 500 counts per minute. Standard voltage is 110 v, 60 cps, ac. Voltage fluctuations on normal industrial circuits have no effect on accuracy. Durant Mfg. Co., 1938 N. Buffum St., Milwaukee 1, Wis.

For more information—
Circle 77, inside back cover

High Output Alternator

A permanent magnet alternator measures 1.6 x 1.8 in. long and weighs 8.5 oz. It has an output of 24 va per phase, 0.33 lagging power factor at 400 cps when driven at 12,000 rpm. Other voltages and current are also available and can be supplied in single, double or three-phase. The device is said to operate continuously for 1000 hr without maintenance and will meet applicable portions of MIL-E-5272A. Harmonic distortion is less than 5 per cent. Applications include use as a tachometer generator and as a source of power for driving servos and gyros. John Oster Mfg. Co., Racine, Wis.

For more information—
Circle 78, inside back cover

Load Cells of 10,000 lb Capacity

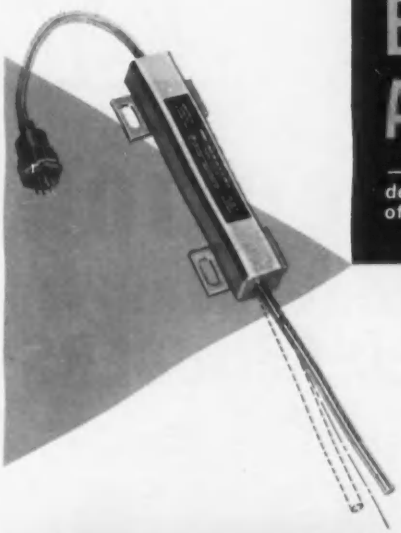
Miniature SR-4 load cells for electrical measurement of forces and weights up to 10,000 lb in compression are less than 2 in. dia and 2¾ in. high. These cells are not intended to replace larger cells of the same capacities and accuracy of measurement. Small size of these special cells was provided at a sacrifice in side load sensitivity. They were developed to measure thrust forces in large steam turbines but may be used wherever

(Continued on page 314)

SELF ALIGNING SHAFT—
linear motion
potentiometers

BOURNS
ALIGN-O-POT*

—highly reliable
despite misalignment
of actuating member



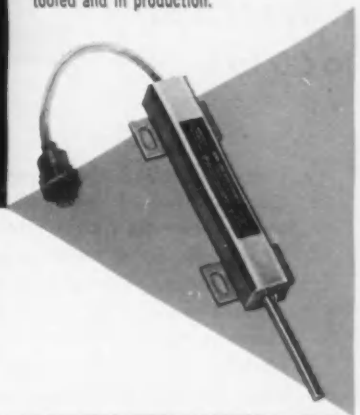
Here is a far-reaching advance in linear motion design. This unit allows for misalignment between the instrument and actuator—eliminating shaft side loads. With no alignment needed, the unit is mounted and installed quickly...is easily designed into a system.

To insure low noise characteristics under extreme vibration, the ALIGN-O-POT wiper assembly is supported throughout its entire travel by parallel guide rods. This provides continuous support directly at the point of contact...multiple contacts are used to further increase the reliability.

The ALIGN-O-POT has a stainless steel case and a flexible cable with plug connector. Standard travels are available from ½" to 6½". Other travels can be provided up to 36". The ALIGN-O-POT is fully tooled and in production.

BOURNS
LINIOMETER®

high performance
under environmental
extremes



The LINIOMETER has a bushing-supported shaft and the same highly reliable internal construction as the ALIGN-O-POT—for use where the self-aligning feature is not applicable. Small cross-section and optional mounting configurations are added features of these units. Available in standard travels from ½" to 6½"

the complete line of linear motion potentiometers

Bourns offers a wide selection of standard instruments for any need from ⅛" to 36" travels—all built for maximum reliability and optimum performance. Bourns will work with you on special requirements.
Write for technical literature.

*TRADE MARK

COPR. BL

BOURNS LABORATORIES
General Offices: 6135 Magnolia Avenue
Riverside, California
Plants: Riverside, California—Ames, Iowa

Do you need a reducer?

Perfection
WORM GEAR SPEED REDUCERS

available in ratios of 5 to 1 to 60 to 1

Perfection Worm Gear Speed Reducers by American Stock Gear are available with ratios ranging from 5 to 1 to 60 to 1 for input revolutions ranging from 300 per minute to 1800 per minute. Speed Reducers may be furnished with worm on top or bottom as desired. Integral worm and shaft is made of selected quality, case hardened alloy steel. Threads are precision ground and accurately mated with worm gear. Shafts are mounted in Timken anti-friction roller bearings. Heavy rigid cast iron housings . . . easily accessible oil filling level and drain plugs are provided for the oil reservoir. Oil seals are of selected cirvis leather which assures maximum sealing effect. Available through your nearest American Stock Gear Distributor. If you don't know his name, write us.

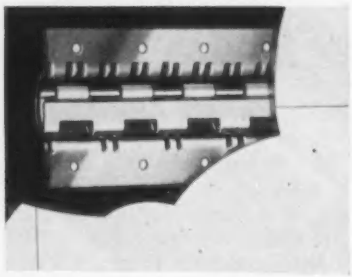
Write for free 8 page Bulletin No. R-20 listing the complete Perfection Series together with tables and other important engineering data.

AMERICAN STOCK GEAR DIVISION
PERFECTION GEAR COMPANY • HARVEY, ILL., U.S.A.

space is too limited to permit use of standard cells of larger size.

Calibration accuracy is within ± ¼ per cent of full range at any load at 70 F. Resistance across power terminals is 120 ohm. Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.

For more information—
Circle 79, inside back cover



Hidden Panel Hinge

Requires ¼ in. max depth dimension behind panel surface for clearance. Rotation of door panel is 145 deg and inherent action of hinge tends to hold door open to allow full access.

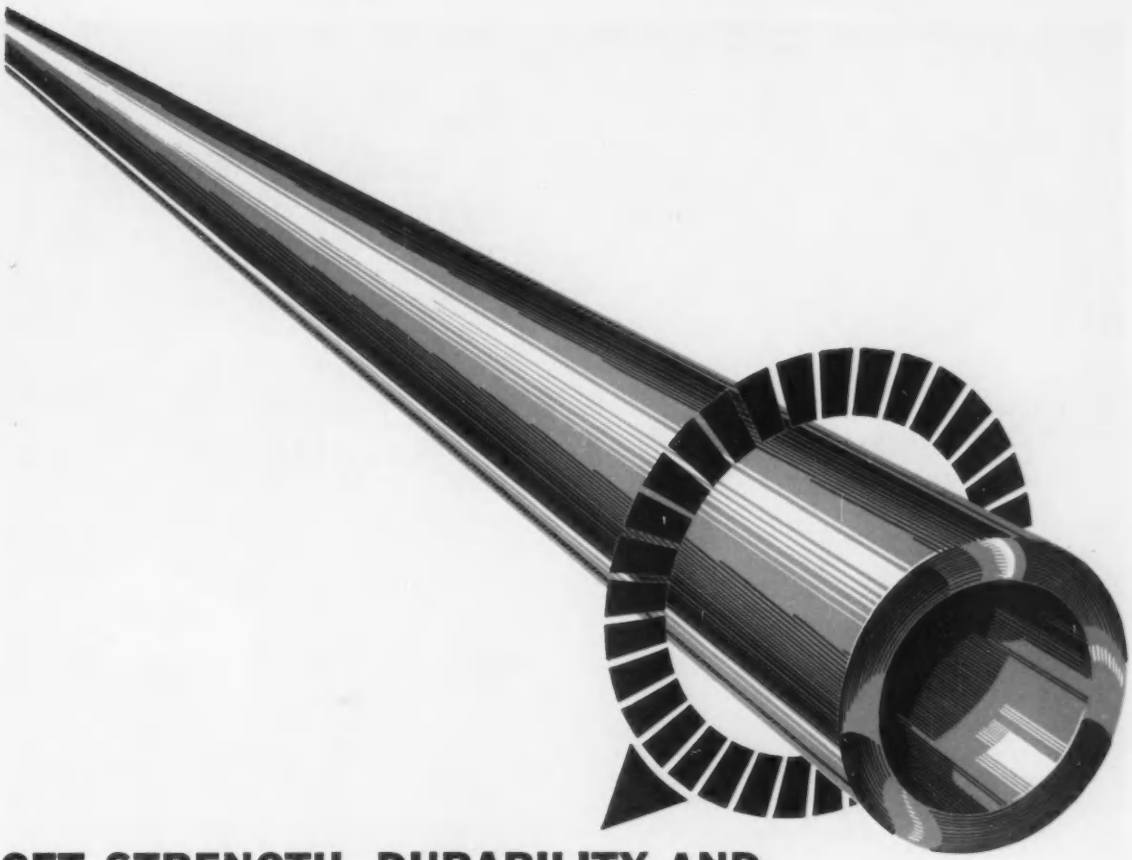
Available in 2 to 6 in. lengths in increments of 1 in. for a variety of frame and door thicknesses. Hartwell Co., 9035 Venice Blvd., Los Angeles 34, Calif.

For more information—
Circle 80, inside back cover

Thermal Relay

This 30-amp unit, equipped with a low current consumption heater coil, can be supplied for an operating voltage of up to 220 v, ac. A time delay setting, factory adjusted, of up to 3 min can be obtained with repeatability maintained at a maximum varia-

(Continued on page 318)



GET STRENGTH, DURABILITY AND LESS WASTE WITH ASARCO CONTINUOUS-CAST BRONZE ALLOYS

You get better parts with longer life . . . tools last longer, too . . . when you use bronze rods, tubes and shapes produced by the Asarco Continuous-Casting process. Asarcon Bronzes are metallurgically superior. Fatigue characteristics are raised 33% to 100% and impact strength is increased from 15% to more than double that of the same alloys produced by other casting methods. Yield strength is up from ⅓ to more than 50%.

Clean-up allowances on Asarcon Bronzes are only 1/32 inch on the smaller sizes and 3/32 inch on the largest. You don't pay for excess casting weight. Machining time is greatly reduced. There are fewer rejects, too, because the Asarco process produces bronzes of exceptional uniformity. Impurities are excluded, alloys are free from porosity, hard and soft spots are eliminated.

And you can order Asarcon Bronzes in mill lengths suitable for automatic screw machine fabrication. Diameters now range from ½ inch to 9 inches in any size you want. Many foundry alloys and a variety of shapes are made to order in all of these sizes. The famous Asarcon 773 (SAE 660) can be shipped directly from stock.

Call or write us for additional information on how Asarcon Bronzes help solve difficult design problems.

Continuous Cast Products Department

AMERICAN SMELTING AND REFINING COMPANY

Perth Amboy Plant, Barber, New Jersey • Whiting, Indiana

WEST COAST SALES AGENT: Kingwell Bros. Ltd., 457 Minna Street, San Francisco

IN CANADA: Federated Metals Canada, Ltd., Toronto and Montreal

ASARCO

In The Continental *Mark II*...
PARKER Die Castings, of Course

PARKER
SALES ENGINEERS

CHICAGO 49, Ill.
Ollie J. Berger Company • 2059 East 72 Street

CINCINNATI, Ohio
William H. Braxterman • 2174 Buck Street

DETROIT 35, Mich.
Hodgson-Geisler Co. • 18917 James Couzens

GIRARD, Penna.
Daniel F. Marsh • 35 Chestnut Street

KIRKWOOD 22, Mo.
Edward F. Higgins, Jr. • 102 West Adams Street

WILTON, Conn.
Girard L. Palmer • Belden Hill Road

SYRACUSE, N. Y.
J. C. Palmer • 712 State Tower Bldg.

BELLEFONTE, Penna.
Warren G. Olson • 420 East Linn Street

To match the skilled craftsmanship exemplified in the CONTINENTAL Mark II, these Parker Die Castings were chosen as components for this fine motor car.

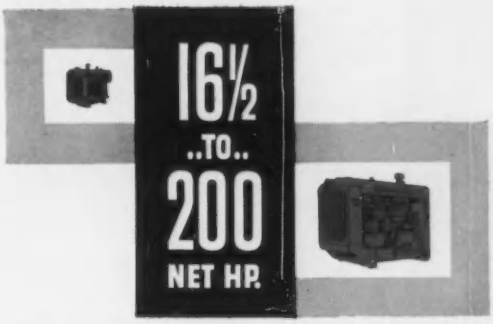
Here is convincing proof of Parker's skill and craftsmanship in the die casting of zinc and aluminum to exacting specifications.

For your die casting requirements, take advantage of Parker's 50 years' experience. Just call the nearest Parker sales engineer or write the factory direct.

Parker White Metal Company • 2153 McKinley Ave., Erie, Pennsylvania

PARKER

high pressure
ALUMINUM and ZINC
die castings
POWDERED METAL PARTS



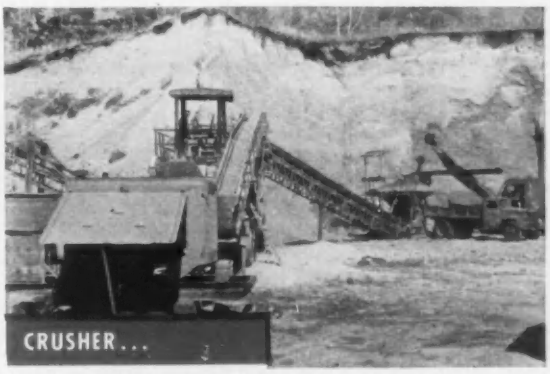
Choose your power from 18 work-proved INTERNATIONAL® UNITS!

Whether you specify engines for new machines, or are working up an optional engine program, there's an International power unit size that correctly fits your needs—be it for shovel, mix plant, grader, compressor, pump, paver, or crusher. Pick any of the 6 diesel, or 12 carbureted, LPG, and gas distillate units, 16.5 to 200 net hp. You'll get heavy-duty engines with the inbuilt tinker-freedom of positive temperature control, that features full-length water jackets. You'll get special-delivery pressure lubrication through drilled passages. You'll get wear-defiant, stress-resistant, induction-hardened crankshaft bearings. You'll get many other International stay-put, extra-value features. And, *your users* will get engines proved by popularity—more heavy-duty International engines have been sold over the last 50 years than any other make.

A 190 hp International UD-24 powers this preparizer which chews up 2 miles of 24-ft pavement per 8-hour day for G. A. Watson, Barneveld, Wis. Says Watson, "I buy International power whenever I can, because their engines are dependable and their field service excellent."

From a wide choice of optional engines, Nello L. Teer Co, Durham, N. C, chose 100% International power for their hot-mix plant . . . a 190 hp UD-24 on the tower, another UD-24 at the dryer, and a 125 hp UD-18A on the fan. Output averages 1,000 tons per 10-hour day.

City of Danville (Va) replaced original engines in their two ½ yd shovels with 75 hp UD-350's. "These International engines have sure cut our operating costs," reports Works Director H. F. Bowling. Each shovel now uses only 17 gallons of fuel to produce 95 five-yard truck loads per day.



For low maintenance crusher power, you can't beat International. This UD-24 has worked 12,000 hours in 7 seasons for Sheboygan County, Wis . . . has produced 700 tons per day . . . yet has needed only one overhaul. "Most dependable engine we know of," says the pit superintendent.

Our design engineers are well qualified to help you select the correct engine sizes and styles for your needs. Write us for details on torque curves and power characteristics.

International Harvester Company, Chicago 1, Illinois

INTERNATIONAL HARVESTER

INTERNATIONAL
INDUSTRIAL POWER

GERING ENGINEERING KNOW-HOW

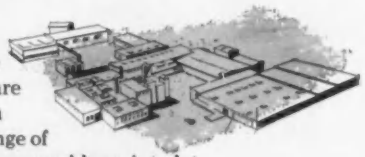
brings you

Better Thermoplastic Extrusions

COMPLETE DESIGN SERVICE!

Nobody could expect a busy design engineer to keep up with all properties of all thermoplastics. That's Gering's job—and we offer highly practical advice on thermoplastics for your specific application. Also ideas on possible design modifications to cut cost or simplify assembly. This is only *part* of Gering's complete engineering and design service—all under one roof...all under one responsibility backed by Gering's knowledge resulting from over thirty years experience of producing high quality plastics.

COMPLETE PRODUCTION FACILITIES!



For fast service—backed by rigid quality control...come to Gering for all your thermoplastic extrusions. At your service are hundreds of dies...complete custom die-making...and a wide range of modern extruders. Why not send us your blueprint—let us bid on your next job. Find out for yourself that Gering means top quality plus dependable delivery...made possible only by one of the most complete and efficient extrusion plants in the world!

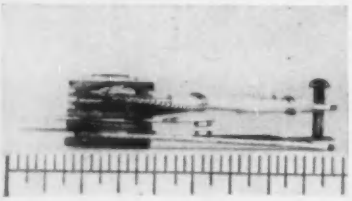
Gering Extrudes

Polyethylene, Acetate, Acrylic, Vinyl, Polystyrene, Butyrate; (Tenite II), Ethyl Cellulose, Copolymers

GERING

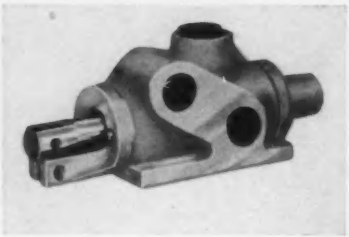
PRODUCTS, INC.

Monroe Street, Kenilworth, N. J.



tion of not more than 10 per cent. Contact arrangement is single-pole, either single or double throw, normally open or closed. Precision Magnetic Devices, Inc., P. O. Box 312, Hackettstown, N. J.

For more information—
Circle 81, inside back cover



Four-Way Hydraulic Valve

For units up to 20 gpm, the valve has a built-in pressure relief on the tank side allowing "tamper-proof" settings. Direct mounting on reservoir-return ports feeds back directly to reservoir, eliminating return lines. Designed and engineered for farm and road building machinery and truck mounted equipment. Wisconsin Hydraulics, Inc., 3165 N. 30 St., Milwaukee 16, Wis.

For more information—
Circle 82, inside back cover

Ball-Bearing Induction Motor

Ball bearings replace usual porous bronze sleeve bearing in a fhp induction motor suitable for temperatures ranging from —40 F to 130 F. Present applications include operation of a timing device that requires instant starting under a wide variety of climatic conditions ranging from arctic cold to tropical heat.

These motors are available with final shaft speeds that range from 300 rpm to 1 rev per week (7 days). Series 500 motors can be supplied as syn-

(Continued on page 321)

NEW *Ambi-stat*

temperature controller could be just what your product needs

It's ambient-compensated... compact... economical

Been looking for a temperature controller . . . in the low-cost bracket . . . that won't be bothered by changes in ambient temperature?

Here it is—the new Honeywell *Ambi-stat*. It's the ideal way to control temperatures in such equipment as bulk milk tanks, dry cleaning washers, vending machines, dishwashers, chicken scalders. It makes a highly dependable alarm . . . for high temperatures, or for frost.

New dependability. For the first time in a low-priced control, you get accurate control action regardless of ambient temperature.

New versatility. Models are available for either heating or cooling applications . . . single or double-throw switching . . . temperatures 0—70 F or 40—180 F . . . nominal differential 2 F or 5 F.

Snap-action switching assures precise, sharp control at the set point. The small bulb . . . $\frac{3}{8}$" in diameter by $3\frac{1}{8}$" long . . . fits readily into your own product design. The complete controller is small, compact, easily mounted on practically any equipment.

REFERENCE DATA:
Write for Specification Sheet No. 866, "Honeywell *Ambi-stat* Remote Bulb Temperature Controllers."

Get complete data, consultation on application, and prices from your local Honeywell sales engineer . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

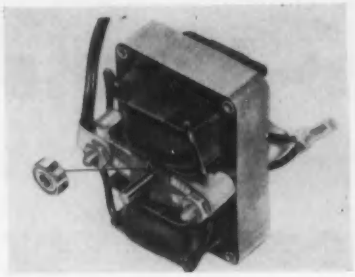
H HONEYWELL

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

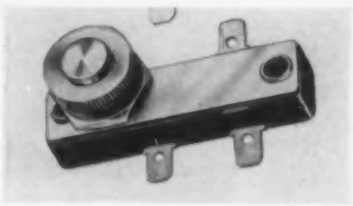
First in Controls

Eaton
Permanent Mold
Gray Iron Castings
Meet Critical Quality Requirements
in a Wide Range of Applications
In applications where more than ordinary quality is required, Eaton Permanent Mold Gray Iron Castings provide a number of desirable characteristics:
Dense non-porous structure
Uniform structure throughout the casting
Machinability at higher feeds and speeds
Higher tensile strength
Ability to take high surface finishes
Freedom from leakage under pressure
These qualities particularly recommend Eaton Permanent Mold Gray Iron Castings for such uses as high pressure control mechanisms, refrigeration and air conditioning parts, power steering and power braking components, household appliance parts, and for many other critical applications.
Eaton engineers will be glad to discuss the application of Eaton Permanent Mold Gray Iron Castings to your products.
EATON
FOUNDRY DIVISION
MANUFACTURING COMPANY
VASSAR, MICHIGAN



chronous or non-synchronous motors, operating on ac only. The motor can be stalled indefinitely without damage to wiring or overheating. Gleason-Avery, Inc., Auburn, N. Y.

For more information—
Circle 83, inside back cover



Snap-Action Switch 5/8 x 9/32 x 7/16 In.

This switch is said to be suitable for applications in appliances, clock-timers, office equipment, automotive, electronic, vending machines. Connecting elements in the spring release mechanism have been eliminated, and there is only one moving part.

The switch is available in four basic designs, varying in operating force from 3 to 12 oz in the pin-operated models, and from 1½ to 12 g in the wire-operated models. Detroit Controls Corp., 800 Union Ave., Bridgeport, Conn.

For more information—
Circle 84, inside back cover

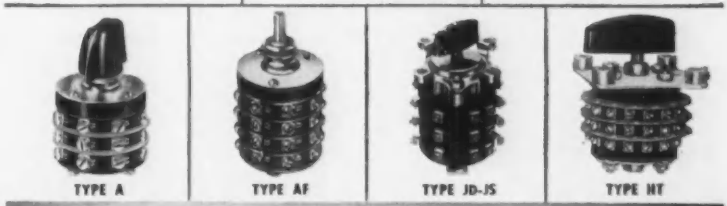
Adjustable Electric Vibrator

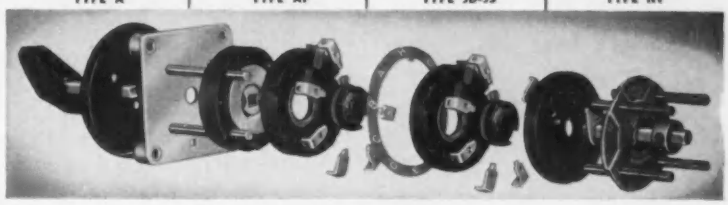
Each end of the vibrator is equipped with two interleaving eccentric weights. The weights may be closed into a semi-circle, giving maximum force, or opened up into a three-quarter circle for minimum vibration. Weights are held together with a bolt.

The RC-10, smallest of the line, has

(Continued on page 324)

SPECIAL SWITCHES are STANDARD with ESCO of Weymouth





When you need a SPECIAL switch . . .

ESCO standard, uniform components can be assembled to meet your requirements; or a deviation from one of our standard types will give you a special switch at a standard switch cost. *Over 90% of our production is SPECIAL in one way or another.*

These standard switches can be modified to fit your application:

- **TYPE A** — up to 8 positions, 7 sections maximum, detent-mechanism, rating 5 amperes — 125 volts a-c/30 volts d-c.
- **TYPE AF** — up to 8 positions, 6 sections maximum, detent-action, rating with resistive load 5 amperes at 28 volts d-c or 115 volts 400 cps, per MIL-S-6807.
- **TYPE P** — Multi-section, up to 4 positions, snap-action, rating 10 amperes — 125 volts a-c, 5 amperes — 125 volts d-c, 30, 60, 100, 200 amperes at 500 volts a-c, or 250 volts d-c. Can be assembled to meet Specification MIL-S-15291.
- **TYPE JR** — up to 8 positions, 30 sections maximum, detent-action, rating 10 amperes at 125 volts a-c, 5 amperes 125 volts d-c.
- **TYPE JD-JS** — up to 8 positions, 5 sections maximum, detent-action or snap-action, rating 30 amperes at 230 volts a-c.
- **TYPE HT** — up to 16 positions, 6 sections maximum, detent-action, rating 5 amperes at 125 volts a-c.
- Bureau of Ships No. 9000-S6202-74085 rating 10 amperes at 120 volts a-c. BuShips 9000-S6202-74090, 9000-S6202-74096, and 9000-S6202-74224, ratings 30, 60, and 200 amperes, 500 volts a-c — 250 volts d-c.

Write for data sheets or catalog on ESCO rotary multipole switches — or send us your requirements and we'll give you full specifications on the ESCO switch that meets YOUR need.

ESCO of WEYMOUTH
ELECTRO SWITCH CORPORATION
Weymouth 88, Massachusetts

Doehler-Jarvis help REGINA floorwaxer

Waxing the floor once took plenty of elbow grease.

Now machines do the muscle work. Do it as you used to – bearing down . . . rubbing hard.

So a mechanical waxer needs a certain amount of weight – as well as speed.

And remember this! A floorwaxer's lot is not a happy one. It should be rugged. What's more, though it hides in a broom closet all its life, it has to look like a million on the sales floor. Compete pricewise, too.

One company . . . The Regina Corporation . . . has done an outstanding job of meeting these requirements. Today, something like four out of every five floor waxers sold are made by Regina.

Regina's methods are deceptively simple. Consider their use of Doehler-Jarvis zinc die castings for base, motor housing, handle swivel, and cover. This one policy, alone, accounts for many of the sales advantages their waxers enjoy.

Take weight! Zinc provides it . . . in just the right measure for efficient polishing combined with easy handling. Die casting helps Regina distribute weight evenly and concentrate it low for balance.

Take strength! Zinc has it and die casting exploits it . . . permitting metal to be concentrated where stresses accumulate, reduced or eliminated where strength requirements diminish or disappear.

Three of Four Big Sales Points stressed by Regina to dealers are founded on the use of Doehler-Jarvis zinc die castings . . . eye catching finish (good die-cast surfaces), efficient polishing action (well-placed weight), rugged serviceability (high-strength metal).

zinc die castings add weight to their sales story

Take appearance! Die-cast zinc surfaces enhance almost any finish you want to name . . . including the new enamels in pastel shades. To get a basic change in shape, as for a new model, Regina simply designs a new die-cast cover to fit.

Take cost! Regina and Doehler-Jarvis engineers work production costs down pretty far. In current models, machining is reduced to light reaming of the bearings, a combination turning operation and the tapping of three holes. Cast-in holes speed assembly with self-threading screws. To save still another operation, servicing instructions are die-cast in bas-relief letters.

There are important cost reduction implications, too, in Doehler-Jarvis service. Regina puts it this way, "We've done business with Doehler-Jarvis for over twenty years. We can count on prompt action when it's called for . . . and when they set up a shipping schedule they hold to it."

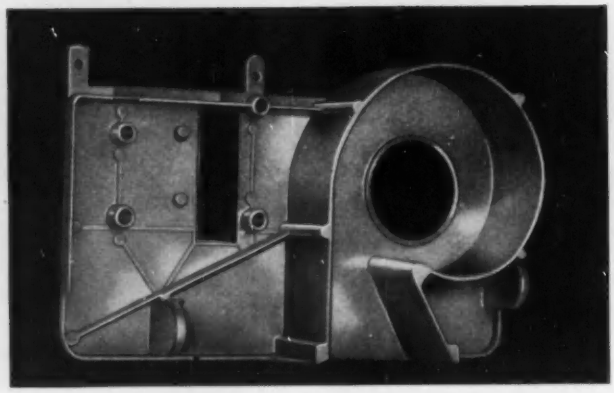
This practical type of relationship has been duplicated many times between Doehler-Jarvis and its customers. For Singer, Black and Decker, York, AMF, Underwood and many another blue chip company it's paid off again and again . . . just as it can pay off for you.

So if you are designing a new product or model, look into the possibilities of die castings . . . Doehler-Jarvis die castings.

Doehler-Jarvis
Division of National Lead Company
General Offices: Toledo 1, Ohio

In Canada:
Barber Die Casting Co., Limited
Hamilton, Ontario

*Reg. U. S. Pat. Off.



Designed to combine a pleasing appearance and functional accuracy this aluminum die casting of a projector housing also includes the added advantage of a minimum of machining and light weight.

Federal
DIE CASTING COMPANY
2228 NO. ELSTON AVE. CHICAGO, 14, ILL
Phone ARmitage 6-4803

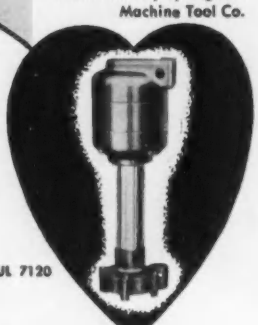
The Heart of a good Coolant System

a Ruthman GUSHER Coolant Pump

This 16" Model 280 Springfield Lathe is equipped with a Ruthman "Gusher" Coolant Pump. Photo courtesy Springfield Machine Tool Co.

Yes, a "Gusher" Coolant Pump is truly the heart of a *really good* Coolant System.

A "Gusher" gives you split-second coolant flow without priming. Its simple design eliminates the need for packing, foot or relief valves and it requires less power when throttled. The dynamic balancing of the entire rotating assembly minimizes vibration. The rugged construction with over-sized pre-lubricated ball-bearings reduces attention to a minimum. The result is a *better*, more dependable performance for all "Gusher" Coolant Pumps.



MODEL UL 7120

THE RUTHMAN MACHINERY CO.
1818 Reading Road Cincinnati, Ohio

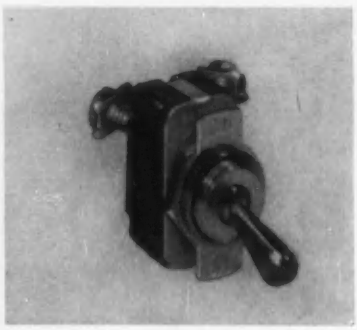
six settings, ranging from 140 to 550 lb of impact. The RC-50 offers a 750 to 2250 lb range with seven settings. Cleveland Vibrator Co., 2828 Clinton Ave., Cleveland 13, Ohio.

For more information—
Circle 85, inside back cover

Miniature Electrolytic Capacitors

These capacitors are available in 42 types. Capacity range is from 0.15 to 160 mfd, voltage ratings from 1.5 to 70 v, dc, and ⅛ to 23/64 in. dia. These units are hermetically sealed, and are said to be inherently low in leakage current. An operating temperature range of −30 C to 60 C is standard. Dept. RW, Barco, Inc., Box 1222, Milwaukee 1, Wis.

For more information—
Circle 86, inside back cover



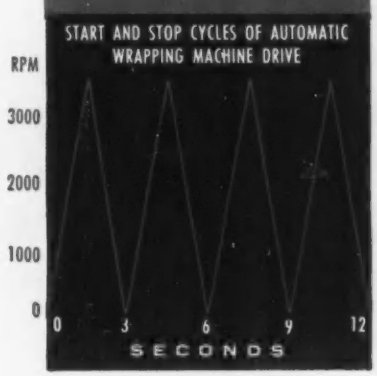
Single and Two-Circuit Toggle Switches

These switches are recommended by the maker for use in power tools and small appliances.

The Model 10 is a single-circuit switch (single-pole, single-throw) equipped with wire leads permanently fastened to the terminals by pressure connections. The Model 10-L is simi-

(Continued on page 327)

20 ROLLS OF "SARAN WRAP" EVERY MINUTE



The Dow Chemical Company's production of "Saran Wrap" has leaped from 130,000 rolls to 4,000,000 rolls a month since 1951. This up-swing is due to a new plant, a new flow system, and additional equipment including new machinery equipped with Reliance V★S Drives.

One of the most dramatic applications of V★S Drives is on the final wrapping machines shown here. The drives must be able to start, accelerate to 3500 rpm., and stop more than 20 times a minute.

The most important feature, though, is not the frequent starts and stops, but the delicately controlled acceleration of the drives. "Saran Wrap" is only 1/6th as thick as a human hair, and sharp or jerky starts will cause a break in the sheet and halt production. Reliance Drives do the job day in and day out without a single break due to uncontrolled acceleration.

RELIANCE V★S DRIVE ®

Whether you handle a thin film of plastic or steel billets, on a complete production line or a single machine, Reliance can give you better quality, more production, and lower costs through Variable Speed Drives. D-2306

Write for bulletin D-2311.

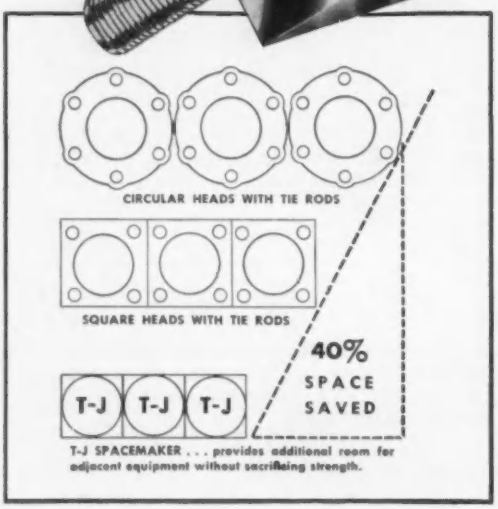
RELIANCE ELECTRIC AND ENGINEERING CO.

CLEVELAND 10, OHIO • OFFICES IN PRINCIPAL CITIES
Canadian Division: Welland, Ontario

Saves 40% Space!

STRONGER, TOO

Than Outmoded Tie Rod Cylinders!



Only T-J **Spacemaker CYLINDERS**

Offer All The Extras As Standard!

- NEW *exclusive* Ingenious Cushion Designs . . . Super Cushion Flexible Seals for Air . . . New Self-Aligning Master Oil Cushion
- Compact design eliminates tie rods, saves up to 40% space
- Proven Performance . . . with Extra High Safety Factor
- Hard Chrome Plated Bodies and Piston Rods (Standard, at no extra cost).
- OIL pressure to 750—AIR to 200 P.S.I.

You'll find many answers to *automation* in your plant with T-J Spacemaker Cylinders! Designed with years-ahead features for top performance and dependability. Wide range of styles, capacities . . . for all kinds of push-pull-lift operations . . . reduces man-hours and costs! Write The Tomkins-Johnson Co., Jackson, Mich.

NEW LITERATURE . . . send today for new Bulletin with complete details of Spacemaker line.

MEMBER OF THE NATIONAL FLUID POWER ASSOCIATION

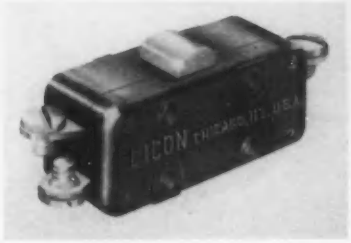
T-J **TOMKINS-JOHNSON**

RIVITORS AIR AND HYDRAULIC CYLINDERS CUTTERS CLINCHORS

lar, but is equipped with soldering lugs in place of the 6-in. wire leads. The Model 10-T is equipped with screw-type terminals.

The Model 12 is similar except that it is a two-circuit unit designed for controlling either of two circuits. It has no off position. These switches are rated 6 amp at 125 v and are UL-inspected. Dimensions are ½ x ½ x 1 in. long. McGill Mfg. Co., Valparaiso, Ind.

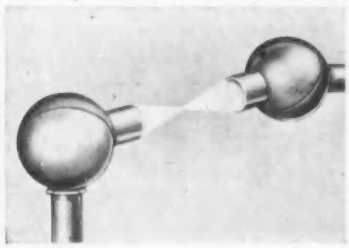
For more information—
Circle 87, inside back cover



Switch Shorter Than Paper Clip

This switch is said to have retained its snap action and high electrical capacity after 20 million test actuations. Shock resistance is 10 G at 2000 cps. The two-circuit switching mechanism consists of beryllium copper switch blades and stainless steel operating spring. Licon Switch and Control Div., Illinois Tool Works, 2501 N. Keeler Ave., Chicago 39, Ill.

For more information—
Circle 88, inside back cover

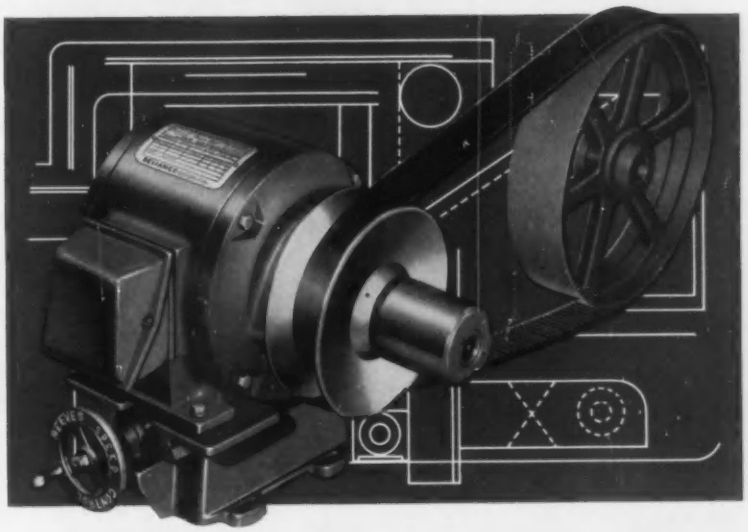


Photoelectric Unit

This cell is contained in a spherical-shaped housing, 5 in. dia. The sphere houses an "eye" amplifier and pilot relay. The only wires out are to the power source and to controlled circuit. The other sphere houses the

(Continued on page 330)

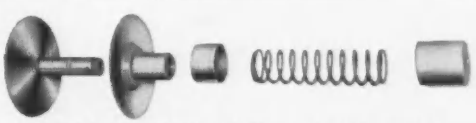
Insure machine designs against early obsolescence



REEVES

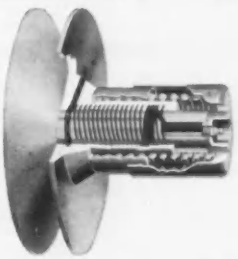
Vari-Speed Motor Pulley

A compact, low-cost variable speed drive that widens machine range . . . adds flexibility. Fourteen models for ⅛ to 15 hp; 1.75:1 to 4:1 speed ratio.



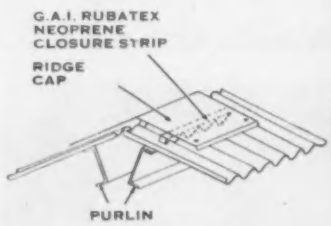
EASY MAINTENANCE . . . LONG LIFE!
JUST 5 SIMPLE PARTS

REEVES "Close-grooving" —a special lubrication system—insures free sliding disc for easy speed changes.

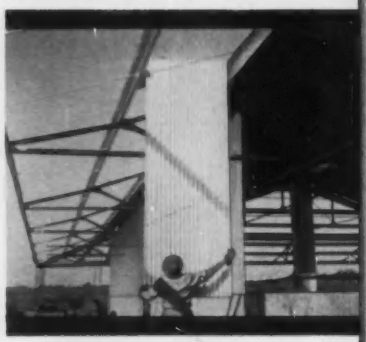


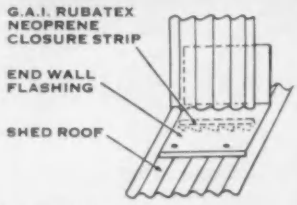
For bulletin complete with rating charts and dimensions, write Dept. K21-V545.

REEVES DIVISION • COLUMBUS, INDIANA
RELIANCE ELECTRIC AND ENGINEERING CO.

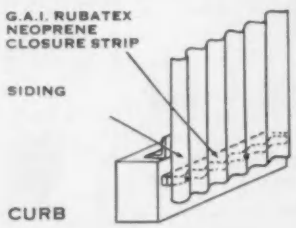


RIDGE

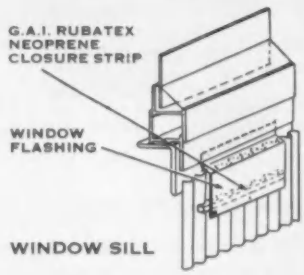




END WALL



CURB



WINDOW SILL

doing unusual jobs unusually well for 20 years

Rubatex is on the materials approved list of REYNOLDS METALS as neoprene closure strips for their Aluminum Industrial Corrugated Roofing and Siding installations. Die-cut to fit corrugations, Rubatex's unique closed cellular structure forms a snug, positive air-, water- and dust-proof seal . . . under aprons of ridge roll . . . with flashing sections at roof junctions, sidewalls or end walls . . . to close bottom of lower course of siding sheets and with flashing sections at window and door openings.

Speaks many industrial languages

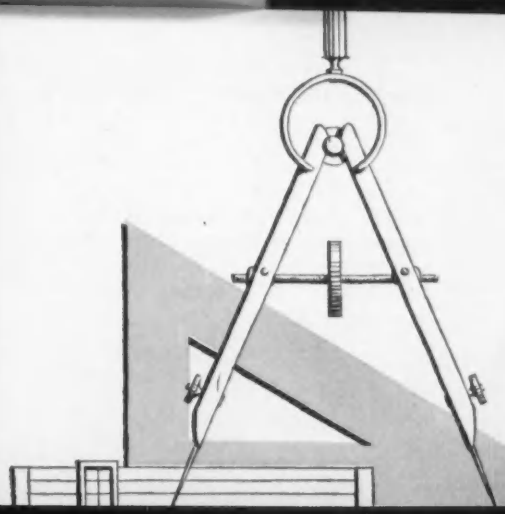
For 20 years manufacturers (top ranking companies as well as smaller concerns) in the automotive, aircraft, electrical appliance, construction, instrument, packaging, shoe, sporting goods, consumer household products and general industries have used Rubatex—for effective gasketing, sealing, cushioning, sound deadening, vibration isolation and packaging jobs. Tested proof that these companies find Rubatex offers advantages no other soft rubber materials can PLUS better performance cheaper. Write us for details on how Rubatex can help your product or application.

G.A.I. RUBATEX

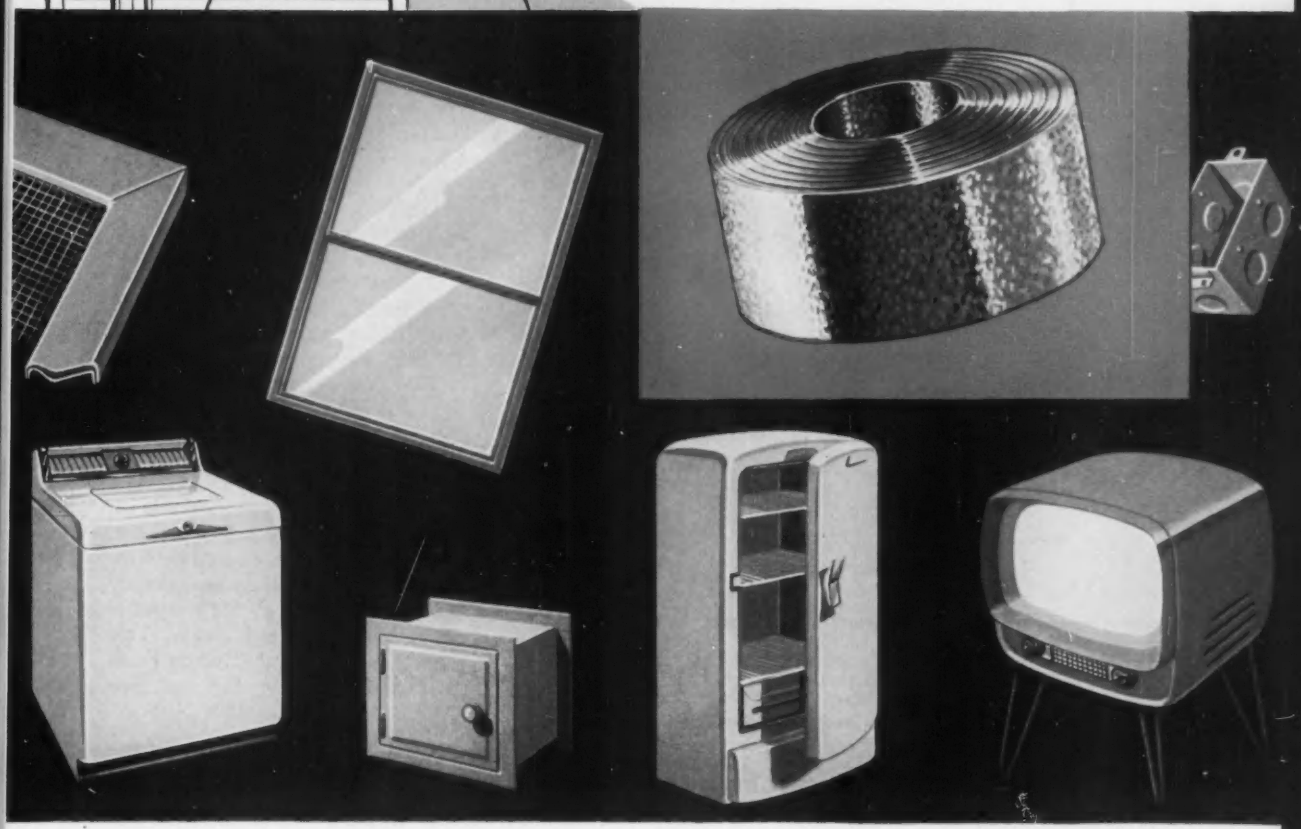
PIONEER MANUFACTURER OF CLOSED CELLULAR RUBBER

also manufacturers of:
Rubatex Insulation Hardboard
Rubatex Closed Cellular Vinyl
Rubatex-Crepe
Rubatex Softee-Crepe
Rubatex Vinyl Foam
Rubatex Plastic Seine Floats

GREAT AMERICAN INDUSTRIES, INC.
RUBATEX DIVISION, Bedford, Virginia



put these bonus advantages of WEIRKOTE galvanized steel to work for you!



For appliances, for other steel products . . . when the job calls for galvanized steel, Weirkote does that job *better*.

Weirkote is made by a special continuous galvanizing process . . . and a tight zinc coating is applied. Result: Weirkote is resistant to peeling, cracking and flaking, even under the severest stresses of fabrication. The coating stays uniform, flows evenly with the base metal, and holds fast under the deepest draws. Amazingly corrosion-resistant, too!

These are just a few of Weirkote's *bonuses* in durability, economy, customer satisfaction. Make it a point to investigate Weirkote from Weirton! Remember: *In the long run, galvanized steel . . . in the LONGER run, WEIRKOTE.*

WEIRTON STEEL COMPANY

WEIRTON, WEST VIRGINIA

a division of

NATIONAL STEEL CORPORATION

Just to name a few . . . and most of the parts we are making to special order don't really have a name! Our real specialty is fabricated wire cloth parts, made to your specifications.

Any metal, almost any size, almost any shape . . . we can probably assemble it for you . . . faster, better and at a lower cost, than you can do it yourself.

For more information, just send for our latest Fabricated Parts Catalog.

NEWARK for ACCURACY

Newark Wire Cloth COMPANY

351 VERONA AVENUE • NEWARK 4, NEW JERSEY

light source lamp. Each sphere mounts directly on the conduit which carries its leads. No other mounting devices or external equipment are necessary. Swivelling to point the eye in any direction is simple. Hancock Industries, 6711 S. Sepulveda Blvd., Los Angeles 45, Calif.

For more information—
Circle 89, inside back cover

Polyester Foam

The main ingredient of this foam is polyester. The percentage of this and the various other components can be changed to give material of high or low resilience. For cushioning, densities between 0.03 and 0.05 (2 and 3.2 lb per cu ft) are ideal, dependent on the loading requirements. For insulation, densities can be lower. The pore size may also be varied, according to the maker.

Polyester foam begins to soften and melt at about 500°F. At just below the boiling point of water (195F) physical characteristics other than color remain unchanged for months. At 400 F it can be compressed for short periods of time without serious distortion.

Foam of 0.04 density gives a value of about 18.8 psi, and at the break the elongation is about 375 per cent. This strength is reported to be more than twice that for medium density foam rubber although the elongation at break of the latter is greater. Tear strength is over 5 psi. Hudson Foam Plastics Corp., Lake Ave. and Saw Mill River Pkwy., Yonkers, N. Y.

For more information—
Circle 90, inside back cover

Instrument Switches

This multi-finger shorting type switch has a fan blade assembly which can be supplied in a variety of combinations, with from 2 to 24 finger blades per deck. The blades are so arranged that they may be obtained contacting consecutive positions or in various groups with specific blades omitted. Single or multi-deck switches are available.

These switches are useful in applications which require the progressive

(Continued on page 334)

Plain bronze, steel or aluminum. Bimetal, with bronze, babbitt or copper-lead on steel.
Straight, clinch butt or special seams.
Oil holes, grooves, cut-outs or windows. Plain or ball-indented.
Steel back. Lengths from ¼" to 6". O.D. from ½" to 5⅛".

GET BEARING PERFORMANCE WITH BUSHING ECONOMY

For many applications our bimetal rolled split bushings give the needed bearing performance characteristics, but at lower bushing costs. Lining alloys to meet specific requirements. Controlled hardness. Large capacity. Complete engineering service. Address:

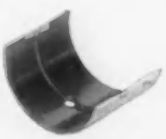
FEDERAL-MOGUL

DIVISION, Federal-Mogul-Bower Bearings, Inc.
11043 Shoemaker, Detroit 13, Michigan

BABBITT-LINED BEARINGS

BEARING-SURFACED THRUST WASHERS

SPACER TUBES

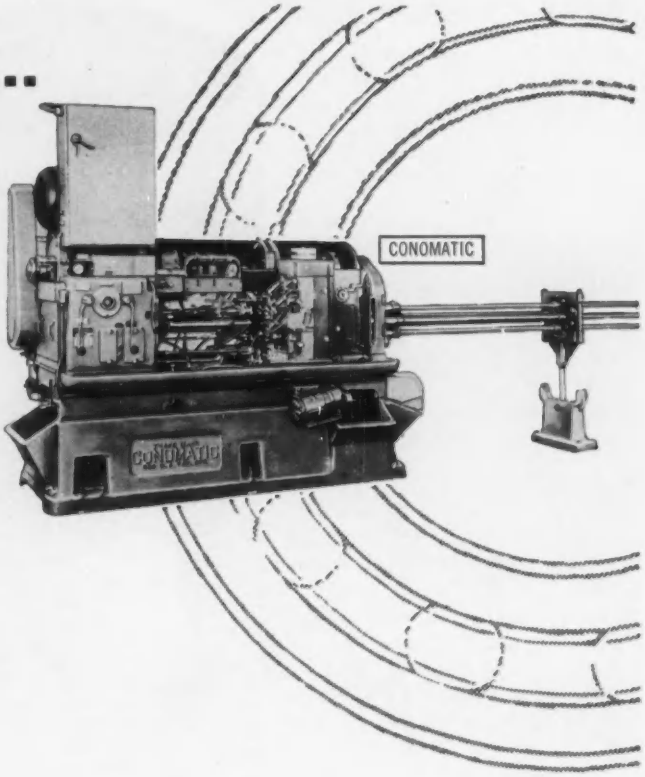

COPPER-LEAD BEARINGS

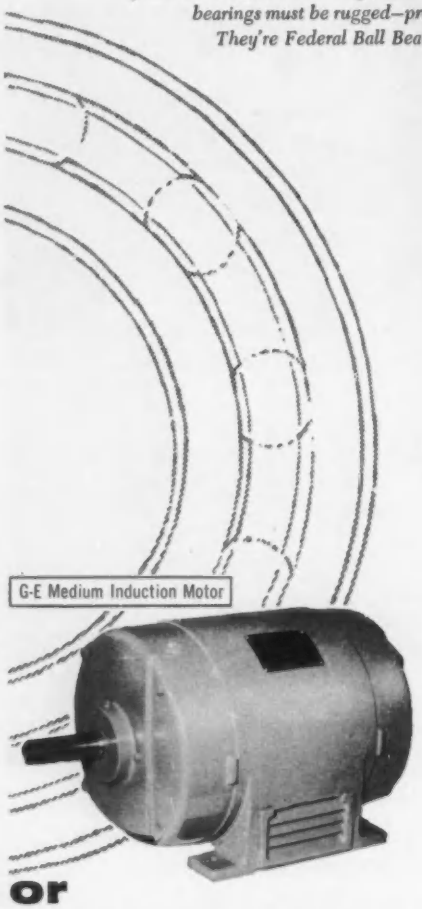
FEDERAL Mogul
SINCE 1899

RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

to feed a tool...

Automatic feed transmissions on newest type Conomatic Six Spindle Bar Machines have to deliver a powerful, steady tool drive under heavy loads for precision carbide machining. Feed shaft bearings must be rugged—precise. They're Federal Ball Bearings.





or quiet a motor...

The smooth hum of today's precision-built motors whispers the efficiency of every part. Here, too, Federal Ball Bearings quietly perform their continuous, anti-friction assignment—whatever the size—whatever the type.

so much of industry *turns* on FEDERAL ball bearings

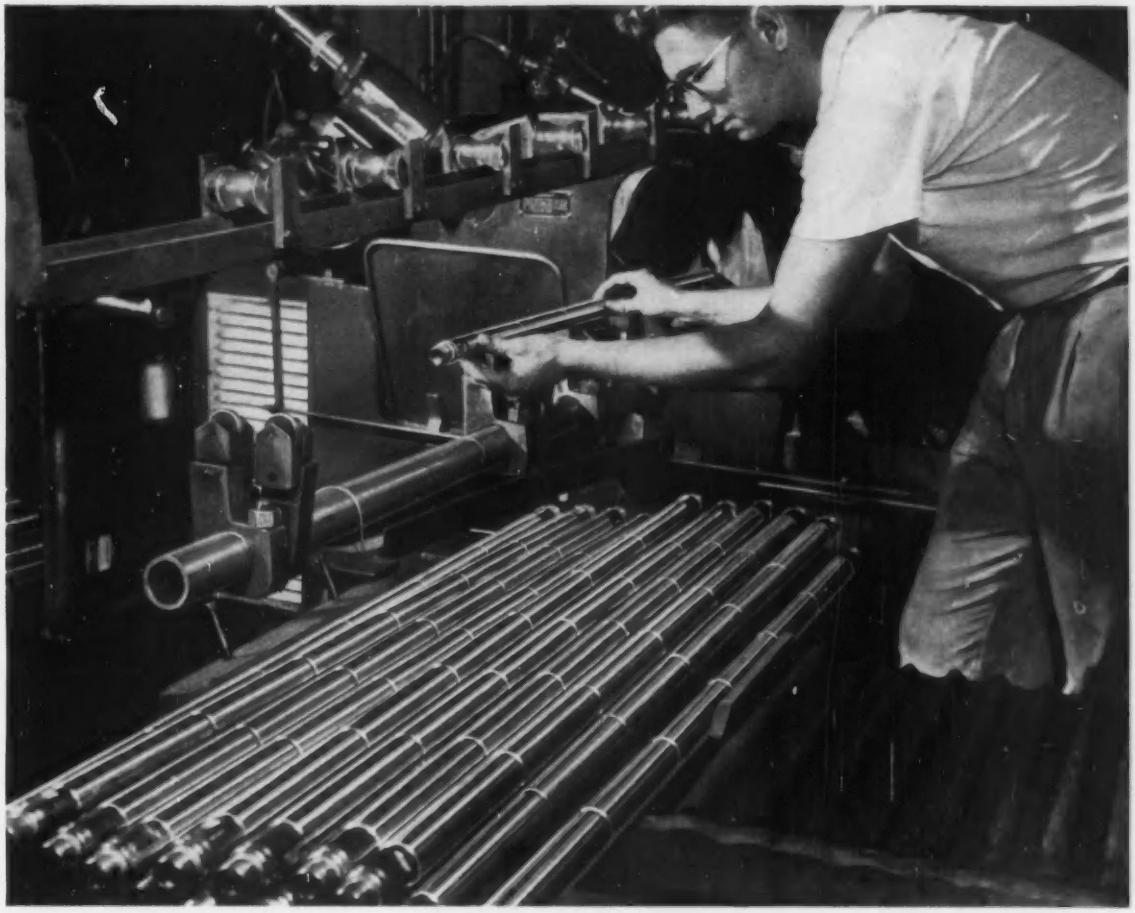
Machine tools—motors—or moving vans! At plant, home, machine shop! On the highway, on the farm—where there's anti-friction work to be done, you'll find Federal Ball Bearings quietly and efficiently on the job. Hundreds of types—12,000 sizes—produced by this 50-year-old manufacturer of ball bearings...exclusively.
When Federal Ball Bearings are a part of so many things you *use*, shouldn't they be a part of the things you *make*?

Just off the presses! *175 pages of ball bearing and engineering data*—FEDERAL'S NEW CATALOG! *Just drop us a line and we'll speed you your copy.*

THE FEDERAL BEARINGS CO., INC. • POUGHKEEPSIE, N. Y.

Federal BALL BEARINGS

One of America's Largest Ball Bearing Manufacturers



THREE SIZES OF TUBING IN ONE PUMP ... PRECISELY!

Like so many products, the deep well reciprocating pump manufactured by Fluid Packed Pump Company of Los Nietos, California, is practically all tubing with the exception of fittings used on the end. And because the pump's components are received as tubes—semi-finished products in themselves—they require much less fabrication than would otherwise be necessary.

For the past 10 years, this company—an acknowledged leader in its field—has used B&W seamless alloy steel mechanical tubing for its product which pumps oil up from subsurface areas of wells. The barrel and plunger of the pump are precision parts which must be held to extremely close tolerances if they are to function properly. The uniform size, wall thickness and concentricity characteristics of B&W Tubing, with its surfaces free from spiral, scratches and pits, combine to make this tubing ideally suited to the Fluid Packed Pump operation.

A closer look at your own product, from both a design and fabrication standpoint, may reveal opportunities for tubing applications that may save time and money and improve your product. Whatever your requirements, B&W Tubing—carbon, alloy or stainless—can meet them. Call Mr. Tubes, or write for Technical Bulletin 365. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

TA-5024M

Seamless and welded tubular products, seamless welding fittings and flanges—in carbon, alloy and stainless steels

DARCOVA PUMCUPS

now available with

100% NYLON COMPOSITION

for HYDRAULIC CONTROLS, AIR CYLINDERS, RECIPROCATING PUMPS

Darcova Pumcup

Darcova 45° Bevel Type Pumcup

DARLING Pumcups—long noted for unequalled efficiency and life in all kinds of cylinders—are now greatly exceeding their own performance records! The new 100% Nylon Composition, available *only* in Darcova Pumcups, does it!

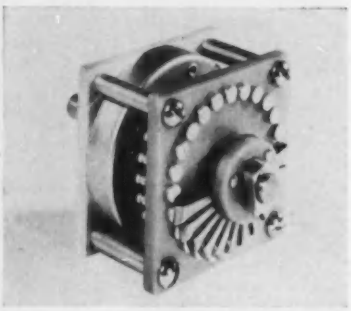
Nylon Pumcups are made in sizes, types and textures exactly right for your particular equipment—ready *now* to give you unprecedented piston packing performance!

Write for helpful data Bulletin No. 5503.

DARLING VALVE & MANUFACTURING CO.
Williamsport 25, Pa.

DARCOVA
THE ORIGINAL COMPOSITION CUP

TRADE MARK
PUMCUPS



shorting of capacitors, resistors or other circuit elements. The switch is 1¾ x 1¾ x 2 in. deep. Daven Co., 530 W. Mt. Pleasant Ave., Livingston, N. J.

For more information—
Circle 91, inside back cover

Mobile Rack for Drawings

This mobile rack, designed originally for maps, rolls on double ball-bearing, rubber-tired casters. It is constructed of welded angle iron, sheet metal and steel rods. It measures 49⅜ x 16⅜ in. and accommodates 80 rolled drawings or maps of any size. Metal-end telescope tubes to be used together for filing or singly for open end filing are available. Ross-Martin Co., P. O. Box 800, Tulsa 1, Okla.

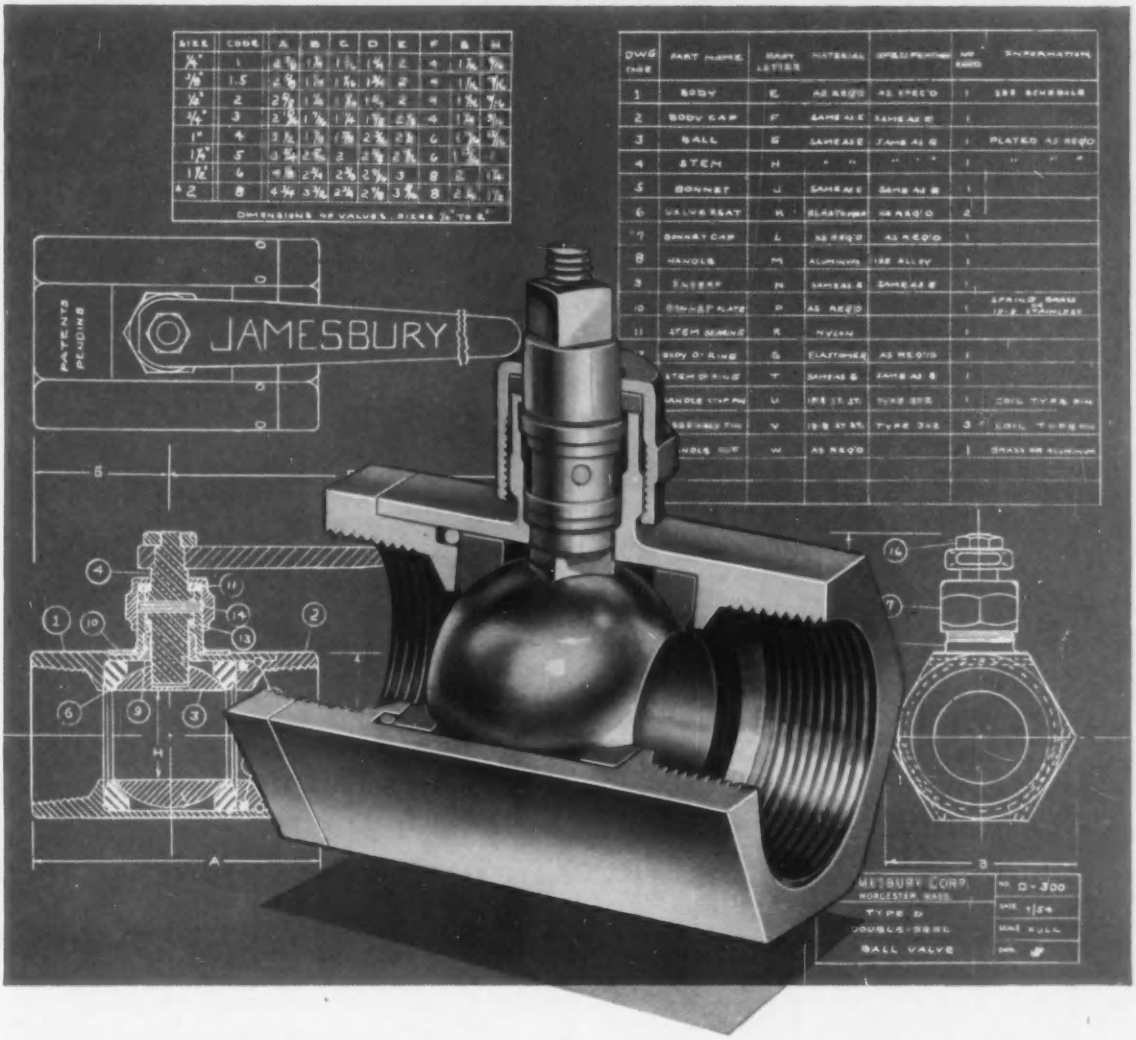
For more information—
Circle 92, inside back cover

D-c Power Supply

A magnetic amplifier controlled power supply with a voltage range of 0 to 32 v, at variable currents from 0 to 10 amp, has been designed. It is

(Continued on page 338)

New, all-stainless double-seal ball valve. Its manufacturer, JAMESBURY CORPORATION, Worcester, Mass., stresses its straight-line flow and elimination of practically all maintenance.



STAINLESS means corrosion-resistance in new double-seal ball valve...

The *all-stainless* construction of this new-type, double-seal ball valve means exceptional resistance to corrosion, erosion and abrasion. That's part of the reason why these Jamesbury valves are being used for chemical applications... processing of hot caustic solutions... even for the vacuum fields.

The valve differs from conventional globe or gate valves in that its operation depends upon a stainless steel ball, sealed with a plastic or rubber ring on both sides. All of the valve, including the ball, is machined from Crucible stainless bar stock, type 303 or 316.

Stainless may be the answer for your product, too. Why not let a Crucible engineer give you the facts concerning its most profitable use? *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

TAYLOR Laminated Plastics Vulcanized Fibre

Shop Talk

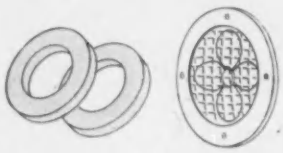
TAYLOR FIBRE CO.

Plants in Norristown, Pa. and La Verne, Calif.

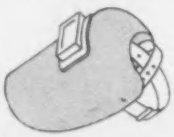
PHENOL—MELAMINE—SILICONE—EPOXY LAMINATES • COMBINATION LAMINATES • VULCANIZED FIBRE • POLYESTER GLASS ROD

Tips for designers

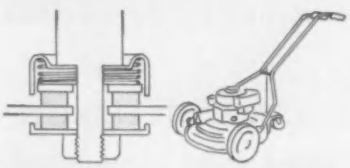
Terminal board for a complex circuit in an electronic spectrophotometer instrument is made of Taylor Grade LE laminate . . . selected for its insulating and mechanical properties.



Large exhaust fans use Taylor paper base phenolic washers to help absorb thrust . . . an inexpensive arrangement, with long life.



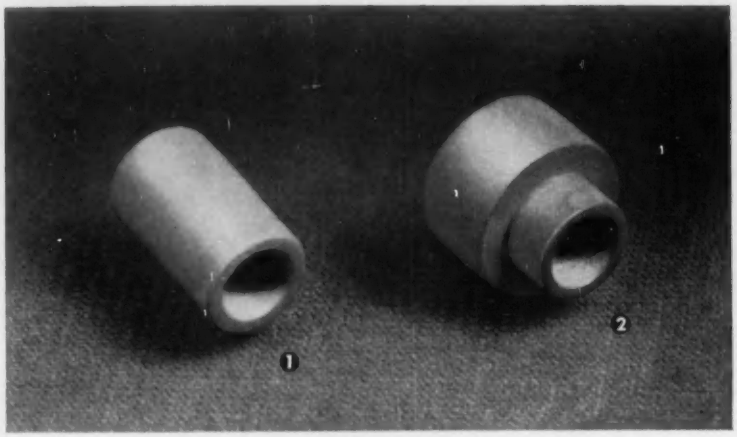
Welders' helmets are fabricated from tough, durable Taylor vulcanized fibre . . . readily formed to many desired contours.



Rotary lawn mower utilizes abrasion resistance of Taylor phenolic laminate washer in slip-clutch attachment of drive shaft to cutting blade.

TAYLOR FABRICATING FACILITIES

Your production problems can often be simplified . . . schedules safeguarded . . . inventory headaches cured . . . and overall costs reduced by having Taylor fabricate finished parts of vulcanized fibre and laminates to your specifications. Efficient, modern facilities are ready to serve you. Write to Taylor about your specific requirements.



Chosen for its mechanical strength and electrical insulation, this Taylor laminated tubing provides an economical means for making (1) an ignition breaker arm bushing and (2) a distributor terminal bushing.

Strength plus electrical insulation, available in Taylor laminated tubing

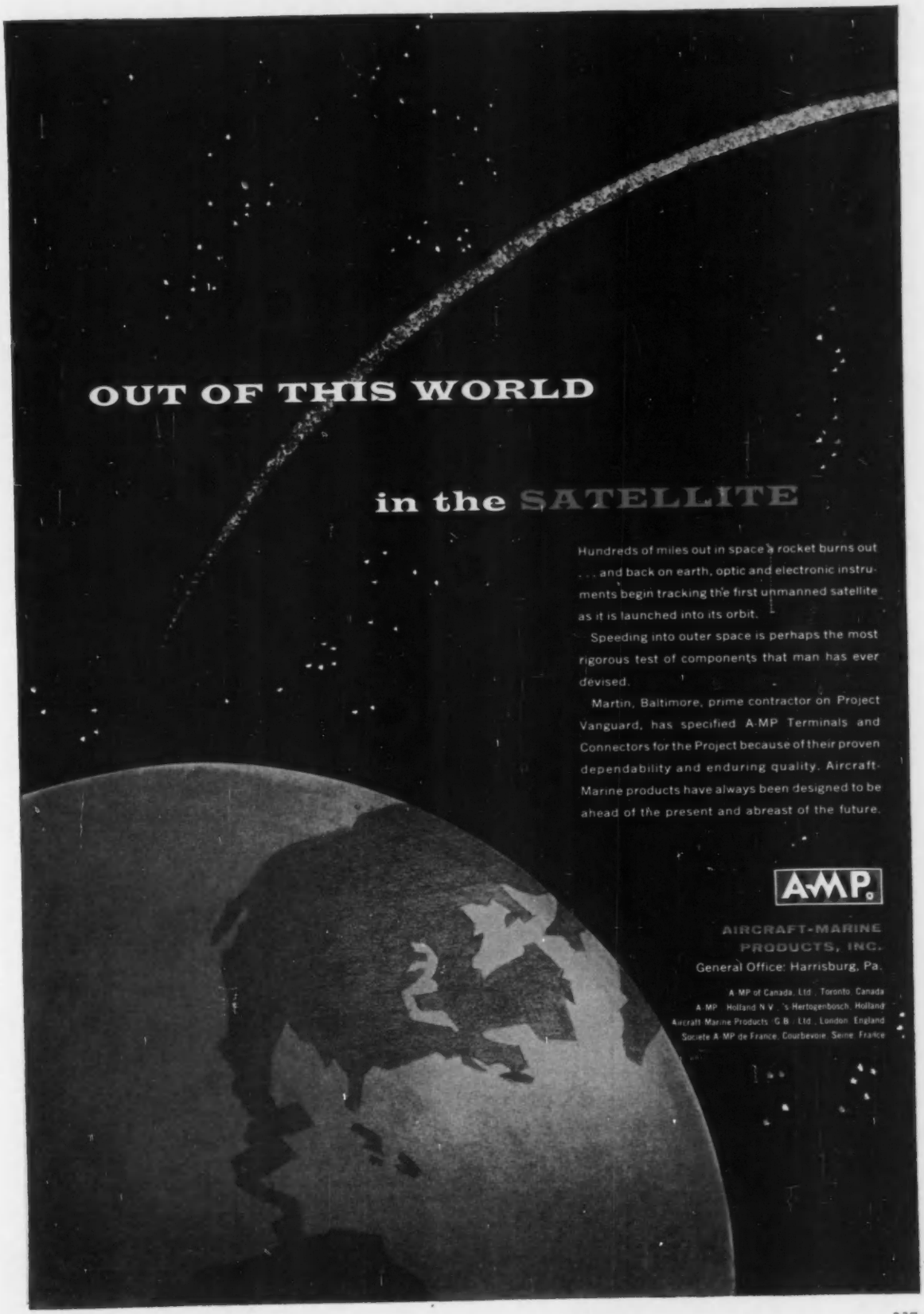
Among the most versatile basic materials available to the designer, Taylor laminated plastics are constantly finding new applications . . . in new products for future markets and as replacements for parts in current production.

Widely used in flat sheets for the fabrication of parts for electrical components, Taylor laminates are also available in tube form. This makes them applicable to an even greater number of parts . . . such as bushings, guides, shafts, and housings for resistors, thermistors and fuses. The tubes are supplied with inside diameters as small as $\frac{3}{32}$". Standard lengths are 36" or 49", depending on grade, inside diameter and wall thicknesses.

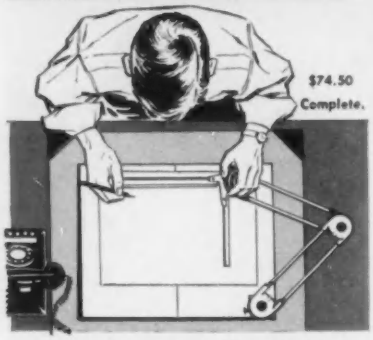
Included in the broad selection of Taylor laminated tubing are a great variety of different grades . . . paper, fabric and glass bases combined with special formulations of phenol, melamine, silicone and epoxy resins. Each grade offers electrical and physical properties which qualify it for a specific application at a reasonable price.

Of particular interest to economy-minded designers and production managers is the fact that this laminated tubing permits the use of a part for a mechanical application without the need for extra electrical insulation.

Plan to take greater advantage of Taylor laminates . . . in tube, sheet and rod form . . . either in your present products or in those which you are now designing. Call or write for a discussion of your specific requirements.


OUT OF THIS WORLD
in the SATELLITE
Hundreds of miles out in space a rocket burns out . . . and back on earth, optic and electronic instruments begin tracking the first unmanned satellite as it is launched into its orbit.
Speeding into outer space is perhaps the most rigorous test of components that man has ever devised.
Martin, Baltimore, prime contractor on Project Vanguard, has specified A·MP Terminals and Connectors for the Project because of their proven dependability and enduring quality. Aircraft-Marine products have always been designed to be ahead of the present and abreast of the future.
A·MP
AIRCRAFT-MARINE PRODUCTS, INC.
General Office: Harrisburg, Pa.
A·MP of Canada, Ltd., Toronto, Canada
A·MP Holland N.V., 's Hertogenbosch, Holland
Aircraft Marine Products G.B. Ltd., London, England
Societe A·MP de France, Courbevoie, Seine, France

SOLVE YOUR DRAWING PROBLEMS



with Universal's NEW
EXECUTIVE
DESK-TOPPER

COMPLETE! Personal size drafting machine, folding drawing board, metal scales, instrument box, carrying carton.

ACCURATE! Designed and built to rigid standards of professional quality.

SAVE SPACE AND MONEY! No cluttered office with unsightly drawing-table and lamp. All items store compactly in one standard desk drawer.

CONVENIENT! Set up (or put away) in 2 minutes time — with all drawing tools immediately at hand.

PORTABLE! Use at office, home, hotel room; on plane or train; or in the field.

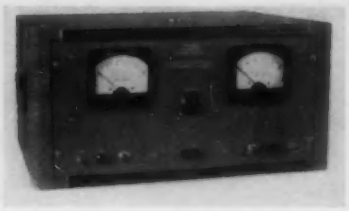
INVEST! IN A *LIFETIME* OF DRAWING CONVENIENCE.

UNIVERSAL DRAFTING MACHINE CORP.
7960 LORAIN AVENUE • CLEVELAND 2, OHIO

Please send me more information on the new Universal DESK-TOPPER!

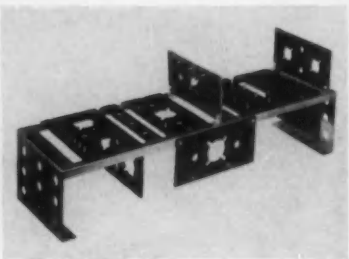
NAME .....
FIRM .....
ADDRESS .....
CITY ..... ZONE ..... STATE .....

MAIL COUPON TODAY!



regulated for line or load to 0.5 per cent. It has the added advantage of continuously variable currents from 0 to 10 amp. Ripple is less than 0.1 per cent for all load and line conditions. Transient response is faster than 0.2 sec. Line input range is from 105 to 125 v, ac, at 50-60 cps. Universal Electronics Co., 1720-22 St., Santa Monica, California.

For more information—
Circle 93, inside back cover



Chassis Kit

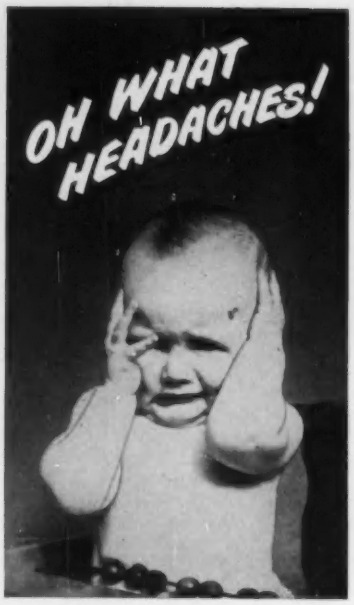
This construction kit consists of end brackets, side channels, terminal strips, miniature and octal tube socket plates, component mounting boards, mounting brackets, double-end press-in terminals, self-tapping screws, potentiometer mounting boards, and rack mounting plates. Plastic used in all mounting boards is 3/32 in. thick, laminated, paper base, XXXP (MIL-P-3115), Type PBE. Precision Metal Products Co., 41 Elm St., Stoneham 80, Mass.

For more information—
Circle 94, inside back cover

Tubeless D-c Power Supply

This magnetic amplifier-regulated power supply, with a voltage output of 5 to 30 v and 10 to 40 v at 30 amp, contains no moving parts. Dimensions are 22 x 15 x 23 in. height in cabinet form. A-c input is 100 to 130

(Continued on page 341)



WISH I HAD ORDERED FROM GARRETT

They never let you down on deliveries when you have to keep production going full speed.

You get *what* you order *when* you order it . . . from Garrett. No waiting for late shipments. You can't beat Garrett service. No worries about Garrett . . . quality. Every Garrett washer, hose clamp, stamping or assembly is right up to the peak of quality. High quality is assured by Garrett's statistical quality control" system.

Next time no more headaches for me. I'll order from Garrett. Why don't you do the same when you need . . .

LOCK WASHERS
FLAT WASHERS
HOSE CLAMPS
STAMPINGS

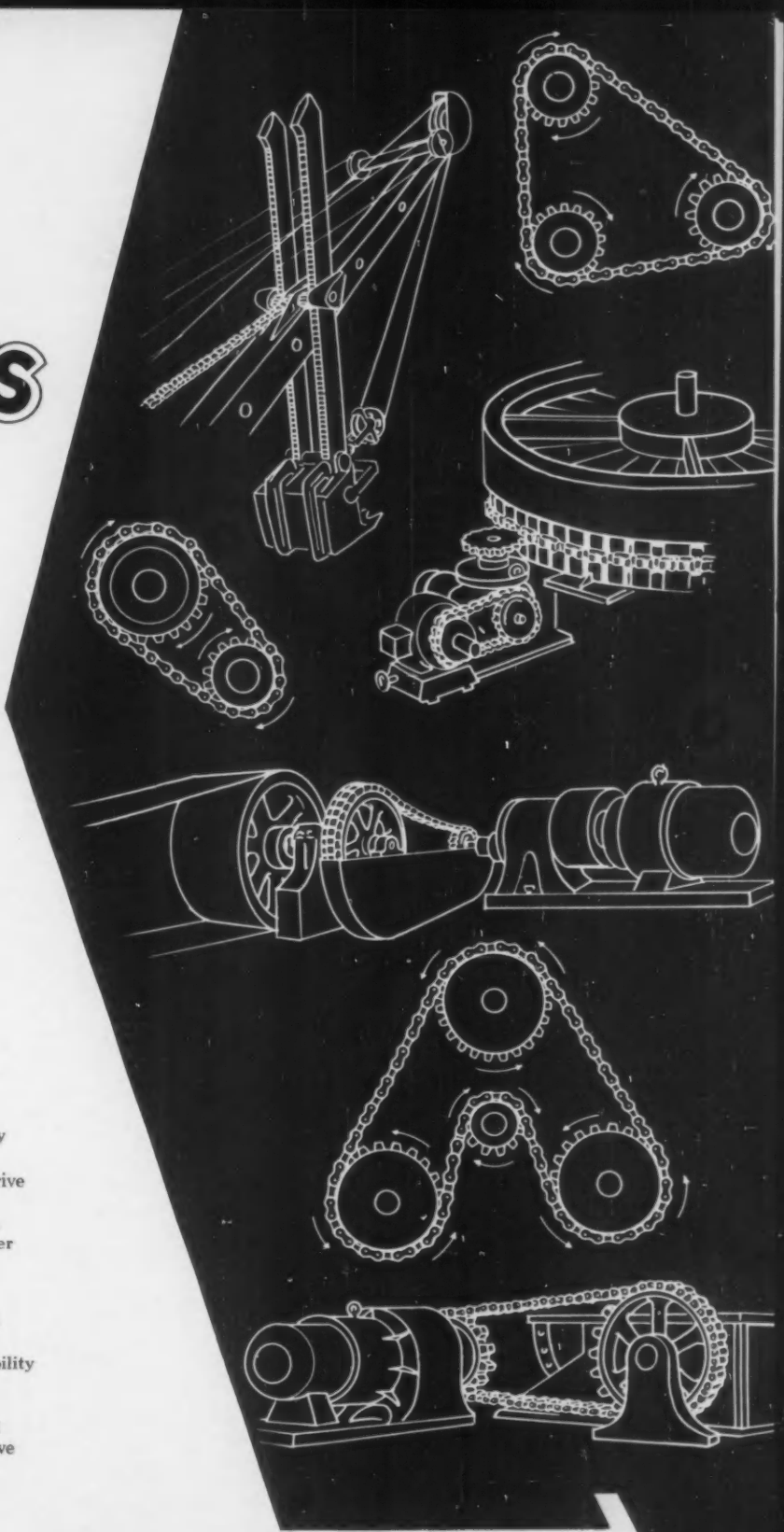
Manufactured by
GEORGE K. GARRETT CO., Inc.
Philadelphia 34, Pa.

Garrett
OF PHILADELPHIA

Idea Sparkers

for

MECHANICAL POWER TRANSMISSION



We wonder, every so often, why many designers seem to take mechanical power transmission mediums for granted — never really try to find a better way of doing it. We're puzzled whether they are really familiar with the many advantages of power chain drives.

So often we see misapplications — gears or belts used when chains are the better choice and vice versa. More important to us, we frequently see the wrong type of chain used — a high speed chain on a slow speed drive . . . a heavy chain on a light load drive. Costly, inefficient applications like this make us wince. Because, after all, there's a *right* chain . . . a *right* size . . . for each application.

Chains have many design advantages . . . so much flexibility . . . that are often overlooked. For example, the ability to resist heat, dust and dirt . . . virtually unlimited choice of center distances . . . space and weight saving advantages . . . offer the imaginative designer almost unlimited opportunity for creative engineering.

TURN THIS PAGE FOR MORE INFORMATION

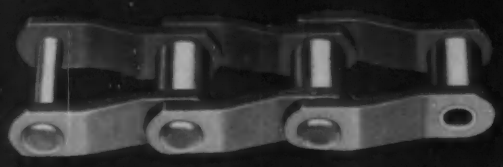
CHAIN BELT COMPANY

LEADERSHIP . . . through creative engineering

IDEA SPARKERS *(CONTINUED)*

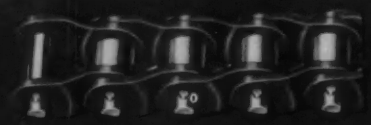
Next time you have a drive problem, why not take advantage of the design flexibility of power drive chains? Our engineers will be happy to work with you. You'll probably save money, increase efficiency. Just mail the coupon below.

There's a right chain for every drive in the complete CHAIN Belt line



REX CHABELCO STEEL CHAINS . . . rugged, heavy-duty chains for slow to moderate-speed, heavy-load drives. Ideal for operation in exposed conditions . . . built-in clearances permit operation in conditions of dust and dirt. Construction equipment, heavy plant drives, elevators, conveyors, drilling rigs, are typical of the type of service where it outperforms other chains.

REX ASA ROLLER CHAINS . . . precision-built chains for moderate to high-speed drives. Exclusive pitch control system assures longest possible service life. Used for all types of drive service such as agricultural implements, packaging machinery, conveyor drives, lift trucks, drilling rigs, mining machinery, printing machinery and general industrial drive service.



REX OFFSET SIDE BAR ROLLER CHAINS combine the high-speed service features of ASA roller chain with the strength and flexibility of Chabelco Chains. Special "built-in" clearances and alloy-heat-treated pins assure long service life under severe operating conditions. They are especially suited to heavy-load operation under dusty, dirty conditions.

REX LEAF CHAINS. While not properly described as power drive chains, these rugged chains are ideal for tension linkage service . . . counterweight mechanisms, reciprocating motions, load carrying, etc. They are widely used on lift trucks where their construction assures greater ultimate strength for a given chain weight, size and cost than with any other chain.

CHAIN Belt Company
Dept. DP-2
Milwaukee 1, Wis.

☐ Send me informative literature on Rex Drive Chains.
☐ I would like to have a CHAIN Belt District Sales Engineer call.

NAME .....
COMPANY .....
ADDRESS .....
CITY..... ZONE..... STATE.....

These are but a few of the many types of Rex Chains for power drive service. There is a right size and type for any application.

CHAIN BELT COMPANY

MILWAUKEE 1, WISCONSIN

v, single phase, 60 cps. Weight: approximately 200 lb. Perkin Engineering Corp., 345 Kansas St., El Segundo, California

For more information—
Circle 95, inside back cover

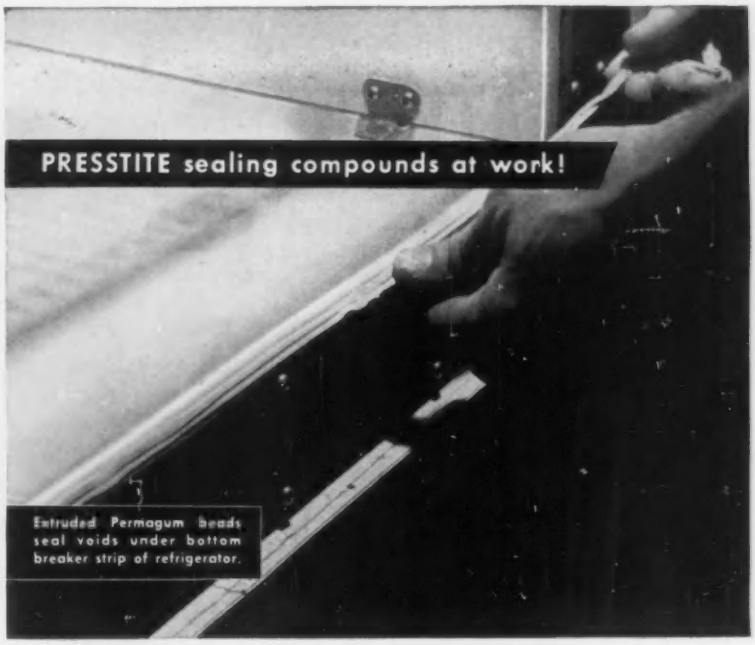
General Purpose Oscillograph

This oscillograph has an internal self-regulating power transformer. This provides performance virtually independent of line-voltage changes. D-c drift in this instrument is said to be scarcely noticeable, even over extended periods of operation.

The linear sweeps are generated by a hard-tube circuit. A beam gate turns the beam on during only the forward sweep. Thus, no retrace is seen and the spot is not visible before sweep initiation. Therefore there is no danger of fogging film in making recordings with triggered sweeps. Also, the possibility of burning the screen with a stationary spot is eliminated.

The cathode-ray tube used is operated at 3 kv accelerating potential to assure high spot brightness even when

(Continued on page 344)

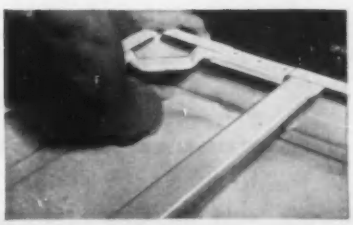


from top to bottom...
refrigerators and freezers sealed with **PRESSTITE PERMAGUMS®**
stay drier and colder

Where effective, permanent sealing is a factor, Presstite's many types of Permagums may be perfectly adapted to the need. They are used extensively, for example, in a wide range of refrigerator applications.

Permagums offer unusual and outstanding characteristics:

- available in extruded beads or tapes and bulk.
- range from soft pastes for gun or knife application to very stiff mastics.
- non-oxidizing, non-drying, non-hygroscopic.
- non-corrosive to all metals.
- highly resistant to water and moisture vapor.
- low odor level.
- non-staining, can be painted immediately.
- unaffected by temperatures ranging as low as —30°F. to as high as 400°F.
- excellent adhesion and cohesion.



Bulk Permagum thumbed into irregular gaps in freezer door.

WRITE TODAY. Describe your sealing application and we will gladly send samples, data and prices.

PRESSTITE SEALING COMPOUNDS
PRESSTITE ENGINEERING COMPANY
3750 CHOUTEAU AVE. • ST. LOUIS 10, MO.

THE LATEST NEWS ON SIMPLIFYING DESIGN

John Macadam, one of National's staff of applications engineers, displays example of the forming versatility of vulcanized fibre.

Versatile Vulcanized Fibre by National reduces cost of dies and molds and simplifies parts for fast assembly.

Today's big news in product design is *simplification* through the use of molded plastic parts. But molding may not be your best answer. *Formed fibre* is often a cheaper—and better—solution!

Look to National Vulcanized Fibre as an engineering material with these advantages:

Lower die or mold costs

Excellent forming qualities

Greater durability—toughness plus resilience

Good heat resistance and dimensional stability

Low material cost

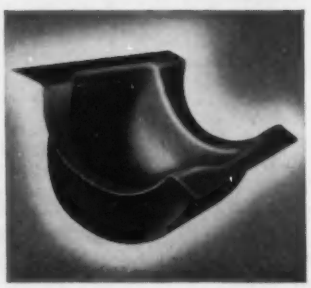
National Vulcanized Fibre and its unique combination of mechanical and electrical properties suit this lightweight, low-cost material to hundreds of difficult applications. And National's generations of experience can always be tapped for answers to your problems.

The typical examples on this page show what can result when our skilled technicians apply versatile vulcanized fibre to your particular job. Consult your nearest National representative about your current materials problem—or write Wilmington, Delaware, Dept. H-4.

See us at Philadelphia—Design Engineering Show—May 14-17—Booth No. 212

Drawn and formed in one operation, the hip guard shown here possesses the resilience, toughness and shape retention that make vulcanized fibre the most used material for protective athletic equipment. Channel draw strengthens structure yet retains necessary spring. The piece is dipped, then baked with synthetic enamel for moisture protection and good appearance.

Punched, formed, scived and flared, this insulator component shows the successful solution of a difficult problem—boxing a channel on all four sides. In fabricating, the blank of vulcanized fibre was first cut to contour, after which the ends were scived, then formed into a box section and flared. This combination of operations makes the piece unusual.



Formed and deep drawn to a depth of 7 inches, this welder's helmet demonstrates the extreme workability of vulcanized fibre. Fabrication was by a single draw with an open bottom die—i.e., fibre was pulled in four different directions. Drawing depth and radii curve are about the maximum limit.

NATIONAL
VULCANIZED FIBRE CO.
WILMINGTON 99, DELAWARE

In Canada: **National Fibre Company of Canada, Ltd.** • Toronto 3, Ont.

VULCANIZED FIBRE • PHENOLITE LAMINATED PLASTIC • PEERLESS INSULATION
KENNETT MATERIALS HANDLING RECEPTACLES • VUL-COT WASTEBASKETS
LESTERSHIRE TEXTILE BOBBINS • VULCOT PRODUCTS FOR THE HOME

J&L CUSTOM-MADE HOT EXTRUDED COLD DRAWN SECTIONS

...boost production, cut over-all costs

Progressive industry is today utilizing J&L's Custom-Made, Hot Extruded Cold Drawn Steel Sections to:

1. **Eliminate time and costs** in machining and finishing operations
2. **Reduce scrap losses** practically to the zero point
3. **Eliminate the cost of castings and forgings** of intricate sections requiring considerable machining
4. **Reduce inventories** due to their quick availability from the J&L plant

These sections can be extruded and cold drawn to the exact specifications of the parts you require—in any quantity you specify. Even the production of a single extrusion can be economical. Obtainable in a wide range of analyses, J&L Extruded Sections can be produced in a large variety of shape profiles—even many of those that cannot be hot-rolled are practical.

The physical benefits of J&L Extruded Sections are equal to or greater than those derived from the cold drawing process, and tolerances are as accurately maintained. The excellent surfaces of these Extruded Sections require little—if any—finishing operations.

Send us your inquiry for prompt and efficient J&L service.

Jones & Laughlin
STEEL CORPORATION · PITTSBURGH

Jones & Laughlin Steel Corporation
3 Gateway Center, Dept. 409
Pittsburgh 30, Pa.

Please send me your new Booklet on *Extruded Sections.*

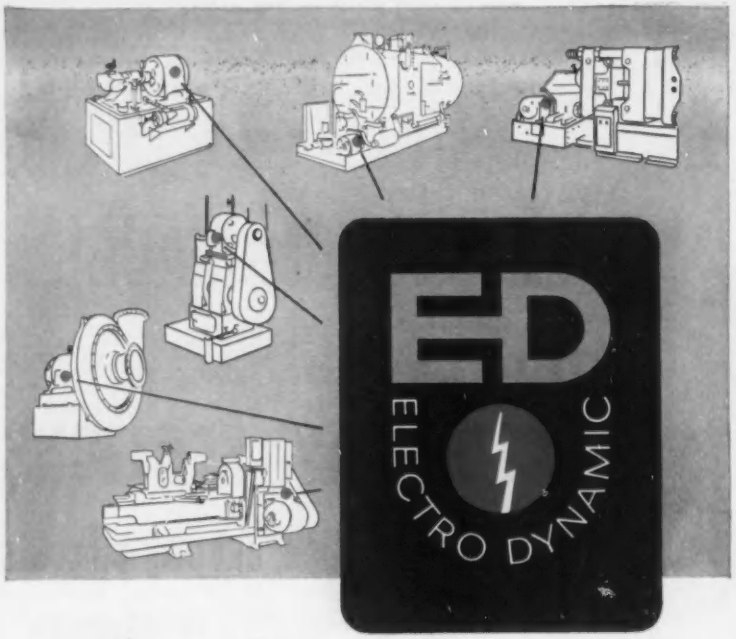
NAME_____

TITLE_____

COMPANY_____

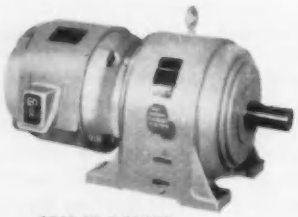
STREET_____

CITY_____ ZONE____ STATE_____



THIS EMBLEM IDENTIFIES EXTRA DEPENDABLE INDUSTRIAL MACHINERY

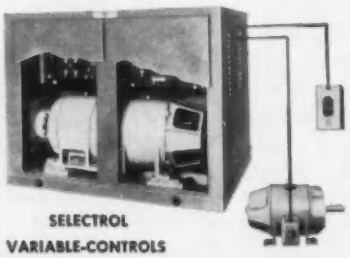
STANDARD MOTORS



GEAR-ED-MOTORS

The red *power spot* on industrial machinery means "Powered by Electro Dynamic." Such machinery relies with confidence on the *extra dependability* of Electro Dynamic motors, the proven industrial motors which give industrial equipment *extra dependable* operation.

SELECTRON VARIABLE-CONTROLS



SELECTROL VARIABLE-CONTROLS

NEW...

Write for Brochure 50 and literature on new E.D. motors and drives.

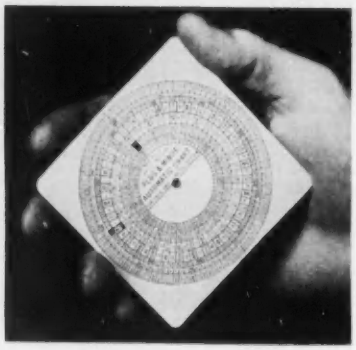
Electro Dynamic division of General Dynamics Corporation Bayonne, New Jersey

GD

ELECTRO Extra DYNAMIC dependable motors

using low repetition rates and long-persistence screens. The unit is designed to operate at 60 cps power, but a 50 cps version will be available. Allen B. Du Mont Laboratories, Inc., 750 Bloomfield Ave., Clifton, N. J.

For more information— Circle 96, inside back cover



Inch-Millimeter Calculator

An inexpensive plastic plus-minus calculating chart, designed to perform the same functions as more elaborate slide rule calculators, is composed of a circle of seven sets of figures, five of which are on the master chart, and two on an over-riding disc. The four inner circles of the calculator chart enable the user to figure from the inch system into millimeters and decimals thereof. The three outer circles are used to make calculations from the metric to the inch system. Charles F. Herbstreith Co., Nutley, N. J.

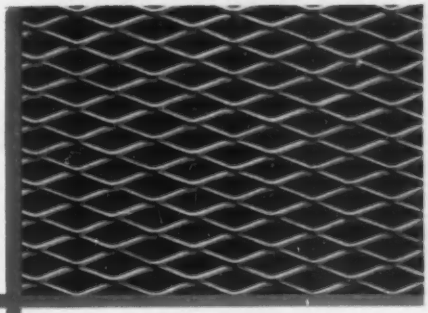
For more information— Circle 97, inside back cover

Strain Gage Kits

Bonded resistance type strain gages made of metal foil for use at normal atmospheric temperatures are offered for experimental and trial use on a no-guarantee basis, in kits including 20 gages, cement, working tools, and instructions. The gages consist of a 0.0005-in. thick copper-nickel foil grid on an epoxy resin backing. Active grid dimensions are 1 x 11/32 in. and mounting dimensions are $1\frac{1}{2}$ x $\frac{1}{2}$ in. Nominal resistance is 119 to 121 ohm, each package of ten gages having a resistance tolerance of $\pm$ 0.2 ohm. Gage factor is approximately 2.20.

(Continued on page 348)

Handsome, functional MINIMESH makes good products better



Minimesh grille protects speaker, transmits sound, adds beauty in new coin-operated phonograph by J. P. Seeburg Corp., Chicago.

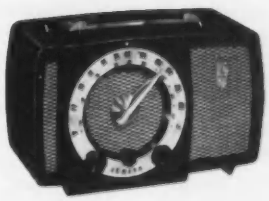
Because it combines beauty and utility — at low cost, Penmetal Minimesh is widely used for decorative purposes and for guards or grilles on stoves, heaters, radios, phonographs, etc. Three famous products, which have been improved with Minimesh, are shown.

Minimesh is small mesh ($^3/_{16}$") expanded metal, and like the larger meshes, is sheet metal which has been slit and expanded up to five times its original width. 80% lighter than solid sheet of the same dimensions, the diamond truss pattern adds rigidity and strength.

The openings in Minimesh permit passage of light, heat, air and sound. Comes in standard or flattened form. Can be cut, shaped or welded to suit design requirements.

Put Minimesh to work for you. Write for new catalog 510-EM, which gives sizes, weights and dimensions.

PENN METAL COMPANY, INC.
General Sales Office: 205 East 42nd Street
New York 17, N. Y.
Plant: Parkersburg, W. Va.
District Sales Offices: Boston, New York, Philadelphia, Pittsburgh, Chicago, Detroit, St. Louis, Dallas, Little Rock, Seattle, San Francisco, Los Angeles, Parkersburg



ABOVE — Zenith Radio Corp., Chicago, incorporates extensive Minimesh grillework in this radio set.

RIGHT — Gas heater by Temco, Inc., Nashville, Tenn. — one in a famous line recently redesigned with Minimesh to bring modern styling to the gas heating field. Open mesh grilles deliver heat.

METAL MARK
Penmetal
1869
OF QUALITY

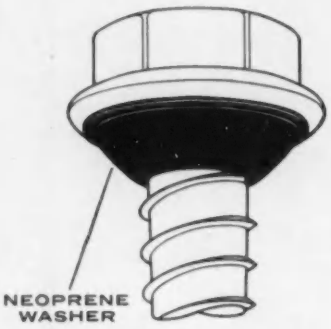
PM-100

For better products

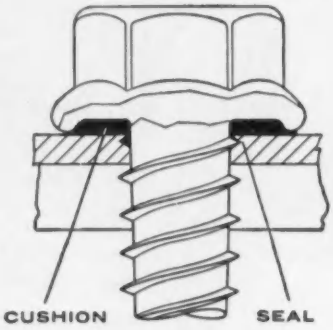
LEAKPROOF...CUSHIONED TUFF-TITE FASTENERS

trademark

Undercut of Tuff-Tite fastener head . . .



. . . confines and controls flow of conical neoprene washer



. . . so washer seals the hole and cushions the fastener head!

Now you can • prevent leaks at fastener holes
• protect fine finishes from fastener damage
• stop vibration noises and squeaks

It's the combination of undercut head design and tough, conically shaped neoprene washer that makes Tuff-Tite fasteners work. The undercut helps confine and control spread of the neoprene washer as it is compressed. The washer's conical shape causes it to flow into top threads and seal the fastener hole.

Tuff-Tite fasteners won't mar fine finishes and they stop vibration noises and squeaks because the neoprene washer spreads itself completely between fastener head and surface. The washer actually cushions the fastener and prevents metal-to-metal contact.

Leakproof, non-marring, shock and squeak absorbing! If you need these fastening advantages, you need National Tuff-Tite fasteners. Write for the Tuff-Tite fastener folder describing this line in detail.

THE NATIONAL SCREW & MFG. COMPANY
CLEVELAND 4, OHIO
***Pacific Coast:* National Screw & Mfg. Co. of Cal.**
3423 South Garfield Ave., Los Angeles 22, Cal.

Tuff-Tite fastener facts

Standard National Tuff-Tite fasteners are available in hexagonal, pan, round and truss head styles for screw diameters No. 6 to $\frac{3}{8}$" inclusive . . . maximum over-all length $1\frac{1}{2}$". Standard fastener types are wood screws, self-tapping screws, thread cutting screws, machine screws and stove bolts. Tuff-Tite fasteners are pre-assembled with neoprene washers.

Washers are molded of neoprene which has a durometer hardness of 85 to 95.

Write for information on *special* Tuff-Tite fasteners.

National PRODUCTS

Fasteners **Hodell Chains** **Chester Hoists**

.....at

ILLINOIS GEAR

Quality always comes first

Quality *that you can trust* characterizes every step of the manufacture of ILLINOIS GEARS.

Skilled craftsmen equipped with the world's finest and most modern tools, plus precision inspection and quality control, with extremely careful attention to materials, heat treatment and tolerances, all combine to produce the finest gears in America.

You want gears that are made right, *with quality as the first consideration*—depend on ILLINOIS GEARS.

Look for this mark (ILL®) *the symbol on finer gears*

ILLINOIS GEARS Reg. U.S. Pat. Off.

Gears for Every Purpose ... one gear or 10,000 or more

ILLINOIS GEAR & MACHINE COMPANY

2108 NORTH NATCHEZ AVENUE • CHICAGO 35, ILLINOIS

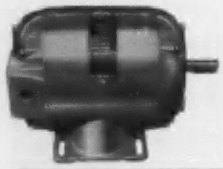
SAVE

on original development costs
by using REULAND ELECTRIC'S

SPECIAL-MOTOR "LIBRARY"

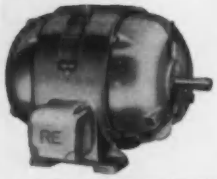
Over 900 Different
Electric Motors

MOTOR #810



CAN BE STALLED OR "LOCKED" WITH CURRENT ON without damage. This torque motor automatically adjusts to intermittent load changes, yet maintains constant power. Available in locked service duties of 5%, 10%, 25%, 50% and 100% with maximum stalls of 5, 10, 20 or 60 minutes, *or continuous* stall.

MOTOR #569

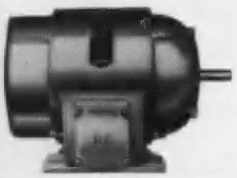


MULTI-SPEED MOTOR operates at different speeds as desired. Available in 2, 3 or 4-speed ratings in the following types:
Constant Torque—Constant torque regardless of motor's speed.
Variable Torque — For loads that maintain their own momentum.
Constant H.P.—Constant H.P. even at reduced motor speed.

MOTOR #617

WAFER-THIN, AIR COOLED, TOTALLY ENCLOSED. Originally designed for ventilation and air moving installations where it could be direct-connected to the fan *within* the piping or vent. Direct-fan attachment eliminates pulleys, belts, brackets and fan shaft. Can also be supplied in open type for mounting out of airstream.

MOTOR #402



HIGH STARTING TORQUE ON LOW STARTING CURRENT, plus variable speed are offered by the Slip Ring motor. Often permits using regular current for getting heavy loads up to full speed. Cranes, heavy fans, printing presses and crushers are typical uses. Available separately or with single or double reduction gear reducers.

REULAND'S "XPANDABLE" DESIGN MEANS ALMOST UNLIMITED ADAPTABILITY...

Don't pay for special motor development until you first check the Reuland SPECIAL-MOTOR LIBRARY. Reuland's revolutionary new XPANDABLE DESIGN idea has produced literally hundreds of unique power packages, one of which may already be the answer to your needs.

Reuland also produces a complete line of standard electric motors. Free engineering literature will be sent upon request. Your inquiry will be given prompt, personal attention.

RE **REULAND ELECTRIC COMPANY**
Distributors In All Principal Cities
Western Division: Alhambra 28, Calif. — Eastern Division: Howell 28, Mich.

Application procedure is approximately the same as for SR-4 wire gages. Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.

For more information—
Circle 98, inside back cover

Circuit Designs on Acetate Sheets

Any standard or special drawing detail, in quantity, on fine matte-surfaced acetate sheets with adhesive on either front or back, is available. To apply, a draftsman peels off protective paper coating and presses the acetate in position. The adhesive is reported not to come off, dry out or wrinkle and is unaffected by any reproduction process. All types of circuit symbols, schematics, standard and special components, cross-sections, sub-assemblies and other repetitive details can be reproduced to order, one or several details per sheet. Stanpat, Whitestone 57, N. Y.

For more information—
Circle 99, inside back cover

Chronometric Hand Tachometer

The instrument covers all speeds from 0 to 300 ipm, with one turn of the large hand in 30 in., each large division on the dial representing 1 in. and each small division ¼ ipm. The tachometer has a guaranteed accuracy of 0.5 per cent. Herman H. Sticht Co., 27 Park Pl., New York 7, N. Y.

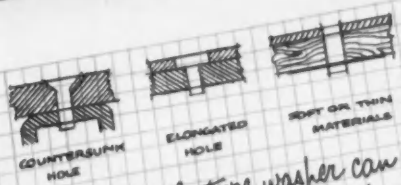
For more information—
Circle 100, inside back cover

Portable Volt-Ammeter

This d-c volt-ammeter is an electrically self-protected instrument. Working in connection with a relay, the moving coil assembly is automatically shorted out whenever there is a dangeous overload. Fused and accurate within 0.5 per cent, this instrument can be purchased either with one or 40 ranges, consisting of the new plug-in type shunt and series resistors. Ranges are 10 milliamp to 25 amp, 15 milliv to 250 v. Sendur Mfg. Co., 3225 N. Sheffield Ave., Chicago.

For more information—
Circle 101, inside back cover

HOW A YOUNG DESIGN ENGINEER PUT BETTER QUALITY INTO HIS PRODUCT

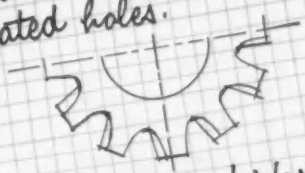


No single type washer can do the *right* locking job on all applications!

We need the right washer for every job... **LOCK** washers that really **LOCK**... such as **SHAKEPROOF'S** job-tailored line

for example, among **SHAKEPROOF'S** nine standards, the countersunk lock washer keeps countersunk screws locked tight!... Or, use the dome type for soft or thin materials and oversize or elongated holes.

for special problems and special savings... **SHAKEPROOF** "Specials" have practically no limit in design or application!



All **SHAKEPROOF**® Lock Washers have tapered-twisted teeth that bite deep, set up strut and spring action to resist backward rotation, **A PERFECT LOCK EVERY TIME!**

So next time use **SHAKEPROOF LOCK WASHERS**

The "job-right" lock washer locks tight every time

Improve quality... **CUT COSTS!**

SEND FOR "SHAKEPROOF SAMPLER"

Write today for SHAKEPROOF LOCK WASHER samples and useful "How to Choose" booklet!

SHAKEPROOF

"Fastening Headquarters"®

St. Charles Road, Elgin, Illinois • Offices in Principal Cities
In Canada: Canada Illinois Tools Limited, Toronto, Ontario

SHAKEPROOF
FASTEX

DIVISIONS OF ILLINOIS TOOL WORKS
World's Broadest Line of Mass-Assembly Fastenings

MORE EFFICIENT DESIGN, IMPORTANT SAVINGS, SIMPLIFIED ASSEMBLY, BETTER APPEARANCE

These are some of the many benefits reported by Design Engineers who have adopted TRU-LAY PUSH-PULLS for remote control operations on literally hundreds of products

Here are typical comments recently received from equipment manufacturers whose machines or implements are equipped with these accurate and dependable remote controls:

Saves Time, Labor and Material
"The use of your flexible Push-Pulls saves us a great deal of time, labor and material. The old linkages frequently required much planning in both engineering and shop which is not required now. On some of our equipment we use Push-Pulls from 10 to 30 feet in length. They operate clutch controls on the Main Power Unit, Feed Conveyors and Delivery Conveyors."

Greater Flexibility of Design
"The principal advantage of Tru-Lay Push-Pulls in our application is that they permit flexibility in locating the control valve in relation to the operator's position."

Cost Less to Install
"Tru-Lay Push-Pulls are easier and less expensive to install than linkages for remote control of power take-off, brake and clutch. Better appearance, too."

Simple and Neat
"For several models of farm tractors, we selected your controls for their simplicity and neatness of application as governor controls."

Solution to Tough Problem
"Can be installed where straight rods are impossible . . . for Remote Control of transmissions, brakes and clutches."

Eliminates Maintenance
"Simple operation and elimination of maintenance problem are the major advantages in using your Push-Pulls."

Reduces Number of Parts
"Your Push-Pulls have eliminated links, radius rods and other lost-motion devices for remote control of hydraulic valves."

Provide ACCURATE Control
"Tru-Lay Push-Pull control cables provide minimum back-lash, even in installations up to 30 feet in length, because the cable is designed to close tolerances with minimum drag and lost motion."

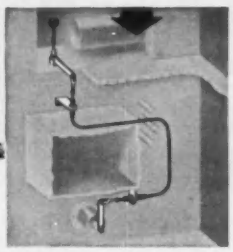
• • •

TRU-LAY PUSH-PULLS are "Solid as a rod but *Flexible* as a wire rope." This flexibility makes it possible to snake around obstructions . . . permits the ideal arrangement of all elements of remote controls.

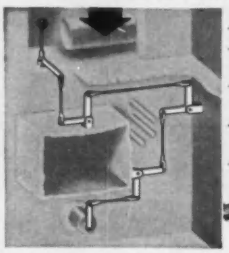
***Advantages** of Tru-Lay Push-Pull flexibility and simplicity are pictured below—*

TRU-LAY PUSH-PULL

Simple
One Moving Part
Life-Time Service
Life-Time Accuracy
Low over-all Cost
Noiseless



MECHANICAL LINKAGES



Complex
Many Parts
Many Points of Wear
Increasing Back-Lash
Loss of Accuracy
Vibration
Rattles

Construction Equipment and **Farm Implements** provide good examples of the wide-spread use of these accurate, simple and dependable Push-Pulls. On Power Shovels, Winches, Graders, Road Oilers, Dump Trucks, Snow Plows, Engine-driven Pumps, Crushers, Tractors, Combines, Corn Pickers, Corn Row Sprayers, Corn Detasslers, Orchard Sprayers, Power-driven Tree Trimmers, Tobacco Picking Machines and others . . .

TRU-LAY PUSH-PULLS are operating unfailingly for the remote control of Hydraulic and Air Valves, Brakes, Clutches, Transmissions, Throttles, Chokes, Governors, Power Take-Offs, Spray Nozzles, Vent Directional Fins and on many other applications.

ACCO *Our DATA FILE will answer all further questions*

AUTOMOTIVE and AIRCRAFT DIVISION
AMERICAN CHAIN & CABLE

601-E Stephenson Bldg., Detroit 2
2216-E South Garfield Ave., Los Angeles 22 • 929-E Connecticut Ave., Bridgeport 2, Conn.

There is No Worry about Failures or Maintenance Costs with TRU-LAY Push-Pull Remote Controls

Long Life is a matter of record. We have never heard of a Tru-Lay Flexible Push-Pull Control wearing out in normal service. Failures, that sometimes harass users of more complex controls, are eliminated by the use of these simple, positive-action controls.

Dependable Operation of these controls is a certainty, even under the most adverse conditions . . . HOT as jet engines (note: Tru-Lay Push-Pulls are actually performing on hot jet applications) . . . COLD to 70° F below zero . . . SOAKIN' WET . . . ABRASIVE . . . or just plain TOUGH.

Freedom from Trouble is assured because of such features as . . . full protection of the inner, working member by the tough flexible conduit . . . lubrication of the inner, working member *for life* during assembly . . . seals that keep moisture, dust and other foreign matter out of the unit . . . cold swaging of fittings that makes them integral parts of the control unit.

Accuracy is inherent in the basic design of Tru-Lay Push-Pulls. They are precision products, not gadgets.

Capacity ranges from light jobs up to jobs of 1,000 lbs. input. These Push-Pulls will handle jobs 150 feet or more from the control point.

"Solid as a rod, Flexible as a wire rope" aptly describes Tru-Lay Push-Pull Controls. This flexibility provides positive, remote action whether anchorages are fixed or movable . . . it damps out noise and vibration . . . it greatly simplifies installation of controls by reducing the number of working parts and by making it possible to snake around obstructions.

Adaptability to all sorts of mechanical situations explains, in large measure, the wide-spread application of Tru-Lay Push-Pulls. Standard anchorages, fittings and heads have been designed that meet requirements on approximately 80% of the installations. Simple modifications of these standards, or minor changes in your own design, cover almost every special situation. Our engineers have the know-how on such matters, and will work with you.

For Further Information—The DATA FILE pictured at the left contains six booklets and bulletins that will answer any further questions you may have about this versatile and dependable tool. It is quite likely that this material will point the way to a simplified solution of your remote control design problems. Write for a copy.

Harvey does not build trailers, but we will be glad to send the manufacturer's name on request.

This trailer floor gives us five years of greater payloads!

Millions of tons of cargo have been shipped in trailers made of long-lasting Harvey Aluminum Extrusions. One of these extrusions is the special floor section shown above. Its shape allows air circulation around the cargo, its light weight increases the payload, maintenance is practically eliminated, and its simplicity leads to increased profits for the trailer manufacturer. A Harvey Engineer can show you how Harvey Extrusions will help your own product's sales and profits. For the over-all story, *send today* for brochure, "Aluminum Extrusions".

Harvey is a leading independent producer of quality aluminum products. Extrusions in all alloys and in all sizes, special shapes, press forgings, hollow sections, structurals, rod and bar, forging stock, pipe, tube, impact extrusions, aluminum screw machine products and related products. Harvey is also producing similar items in titanium and steel.

Making the most of aluminum ...for everyone

HARVEY Aluminum

Harvey Aluminum Sales, Inc.
Torrance, California
Branches in principal cities

When products can be designed with less material...

Have greater strength and rigidity...

Yet cost less to manufacture...

WHY

aren't more of your products designed for welded steel?

Ask

THE LINCOLN ELECTRIC COMPANY

Cleveland 17, Ohio

Pioneer in Welded Structural Design ...for Lower Cost

CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover. For those catalogs and bulletins available only when requested on company letterhead, see page 378.

Special Nuts–Folder, 4 pp, outlines range of forms, metals, threads, tolerances, facings, slottings and machining which can be handled in developing nuts for specific applications. Wood & Spencer Co., 1930 E. 61 St., Cleveland 3, Ohio.

Circle 102, inside back cover

Bottle Oilers and Oil Cups–Circular 580, 4 pp, describes constant level oil controls, bottle oilers for plain bearing lubrication, glass body oil cups, aluminum body oil cups. Lunkenheimer Co., P. O. Box 360, Cincinnati 14, Ohio.

Circle 103, inside back cover

High Yield Strength Steel–Booklet, 24 pp, uses charts, graphs, sketches and photographic illustrations in describing this engineering material, which is available in thicknesses from $\frac{1}{16}$ to 6 in. and above, and in standard widths up to and including 195 in., with a maximum length of 720 in. Lukens Steel Co., Coatesville, Pa.

Circle 104, inside back cover

Expansion Joints–Catalog 53, 24 pp, gives details of construction and specifications together with directions for ordering and application data for various piping systems. Cook Electric Co., 2700 N. Southport Ave., Chicago 14, Ill.

Circle 105, inside back cover

PVC Pipe Fittings and Flanges–Catalog, 12 pp, describes pipe fittings and flanges in normal impact grade and high impact grade, rigid, unplasticized polyvinyl chloride. Shows characteristics, advantages and limitations. Lists operating pressures, temperatures, applications, price comparisons, fabrication advice, installation and supporting recommendations, dimensions and weights. Grinnell Co., Inc., 260 W. Exchange St., Providence 1, R. I.

Circle 106, inside back cover

Reversing Motors–Bulletin 1800, 4 pp, has cutaway view showing the construction of a blower-cooled, rapid-reversing motor capable of more than 200 idle reversals per minute. Engineering information given consists of formulas on inertia and motor reversal calculations. Louis Allis Co., Milwaukee 7, Wis.

Circle 107, inside back cover

Hardware–Catalog, 12 pp, describes line of hardware built to armed forces specifications. J. H. Sessions & Son, Bristol, Conn.

Circle 108, inside back cover

Wire Gage and Footage Chart determines gage and footage readings in Brown & Sharp (AWG) wire gauges. Readings are for beryllium copper, phosphor bronze, titanium and other non-ferrous alloys. Dept. V, Little Falls Alloys, Inc., 189 Caldwell Ave., Paterson 1, N. J.

Circle 109, inside back cover

Solenoid Valves–Bulletins (2), 2 pp each, give JIC specifications for four-way, four-port valves, in $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$ in. sizes. Automatic Valve Co., 37415 Grand River Ave., Farmington, Mich.

Circle 110, inside back cover

Interval Timers–Bulletin 203, 4 pp, describes line of electrical timers, for repeat or non-repeat manual or automatic operation. National Time & Signal Corp., 21800 Wyoming Ave., Detroit 37, Mich.

Circle 111, inside back cover

Alloy and Stainless Steels–Catalog 175A, 102 pp, includes chemical compositions, representative mechanical properties of corrosion-resistant, heat-resistant, impact and abrasion-resistant alloy steels. Electric Steel Foundry Co., 2141 N. W. 25 Ave., Portland 10, Ore.

Circle 112, inside back cover

Electrical Specialties–Catalog, 352 pp, includes switches of all types in ratings from 0.75 to 20 amp; brass and phenolic lampholders equipped with push-button or pull-chain switches;

(Continued on page 356)

new LORD bonded rubber pivot joints never need lubrication

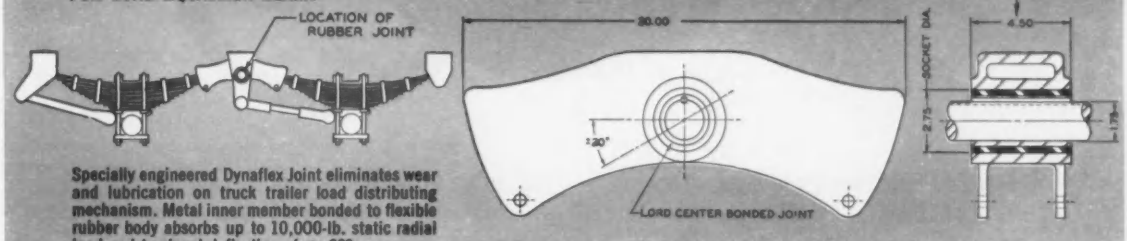
LORD DYNAFLEX® JOINT—a long-wearing, lubrication-free resilient bearing for pivots.

With LORD Dynaflex® Joints you have a new, better answer to problems on pivot joints. One that eliminates wear and lubrication . . . absorbs shock and reduces noise . . . assures mounting and alignment accuracy.

These new, high-capacity resilient bearings provide positive cushioned action—and accommodate static and dynamic radial loads encountered in heavy duty commercial vehicles, torsional deflections up to ± 30° and angular deflections up to ± 7°. Fatigue-defying flexing elements are specially compounded rubber, permanently LORD-bonded to steel members. Design is simple and compact, requires no close tolerances, and usually will fit present equipment with little or no change in mating parts. No metal rubs against metal.

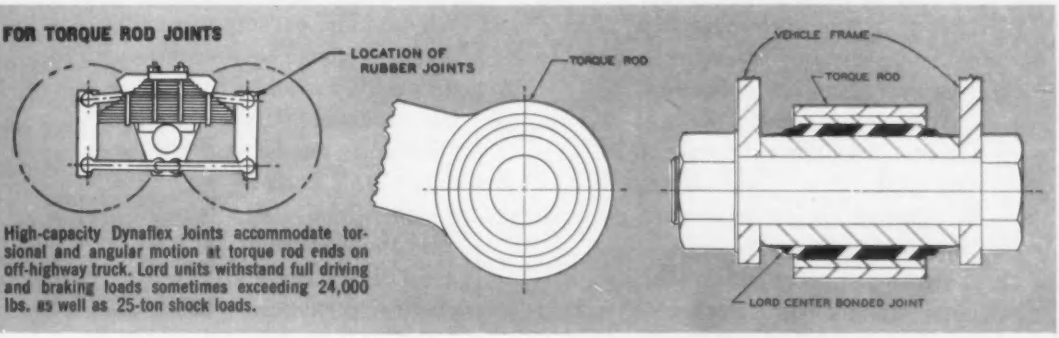
Bonded rubber Dynaflex Joints are the product of LORD development engineers who can produce special designs to solve your specific pivot point application. For further information, contact your nearest LORD Field Engineer or write the Home Office, Erie, Pa., for Bulletin No. 703.

FOR LOAD EQUALIZER BEAMS



Specially engineered Dynaflex Joint eliminates wear and lubrication on truck trailer load distributing mechanism. Metal inner member bonded to flexible rubber body absorbs up to 10,000-lb. static radial load and torsional deflection of ± 20°.

FOR TORQUE ROD JOINTS



High-capacity Dynaflex Joints accommodate torsional and angular motion at torque rod ends on off-highway truck. Lord units withstand full driving and braking loads sometimes exceeding 24,000 lbs. as well as 25-ton shock loads.

NEW YORK, N. Y. - Circle 7-3326 • PHILADELPHIA, PA. - LOcust 4-0147
CLEVELAND, OHIO - SUperior 1-3242 • DAYTON, OHIO - Michigan 6871
DETROIT, MICH. - TRinity 4-2060 • CHICAGO, ILL. - Michigan 2-6010
DALLAS, TEXAS - Riverside 3392 • LOS ANGELES, CAL. - HOllywood 4-7593
"In Canada—Railway & Power Engineering Corporation Limited"

LORD MANUFACTURING COMPANY • ERIE, PENNSYLVANIA

LORD BONDED RUBBER

designers and producers of bonded rubber products since 1924

this is important enough to read twice!

● Here's Frenchtown's answer to an important engineering need . . . perhaps your very own.

Now, *for the first time*, you can obtain 1, 2, or a dozen prototype *high alumina ceramic* parts for development work in your own plant . . . at low cost.

This new service, developed by engineers for engineers, is available to "custom-make" any small-lot number of Frenchtown *engineered* ceramic parts to your exacting specifications.

Here's an opportunity to put high alumina ceramics "through the mill" to help you solve a materials problem for a new product . . . or help you improve an existing one, without the barrier of buying production run quantities.

Why not find out more about the plus-advantages offered by Frenchtown's Prototype Service? Write, outlining your problem. Ask, too, for a copy of this 4-page bulletin which describes the complete line of Frenchtown *engineered* ceramics.

frenchtown PORCELAIN COMPANY

87 MUIRHEAD AVENUE | TRENTON 9, NEW JERSEY

California Representative: Edwin E. Starr, 4101 Rhodes Ave., North Hollywood, Cal. STanley 7-5879.

CORNING GLASS BULLETIN FOR PRODUCT DESIGNERS

CORNING GLASS WORKS, 51-4 Crystal Street, Corning, New York
Please send the material checked below:
- ☐ Illustrated booklet: "Glass and You."
- ☐ Bulletin B-83: "Properties of Selected Commercial Glassware."
- ☐ Bulletin B-84: "Manufacture and Design of Commercial Glassware."

Name_____
Title_____
Company_____
Address_____
City_____ Zone_____ State_____

How to make a point—painlessly

In the syringe behind the needle, which your dentist wields so deftly, is a neatly prepackaged dose of anesthetic. These containers are glass tubes stoppered at both ends.

We call these painkiller packages "cartridges," and fashion many of them of a PYREX brand glass. The specific glass used goes under the somewhat undramatic name of glass No. 7740.

While the title may be lacking in imaginative quality, the glass is not. Consider, for a start, the fact that the glass cartridges must be made to close inside-outside tolerances because (a) rubber stoppers must fit snugly inside and (b) the cartridge itself needs nestle neatly in the dentist's hypo or syringe.

These close fits demand fire polishing the ends (so they won't chip) without impairing dimensional tolerances—quite a delicate operation for mass production.

The glass tube must be capable of being sterilized without undue strain or breakage; it must be chemically inert so it neither adds to nor detracts from the quality of its contents. And the cartridges must be economical as, in the interests of sterility, they are used once and discarded.

So far, so good. This PYREX brand glass No. 7740 meets all the counts—and then some. It's a glass that's easily formed into intricate shapes, by varied methods, including inexpensive, one-piece molding.

For most general purpose use, No. 7740's reluctance to interfere with chemicals is without peer. Its unusual thermal expansion coefficient (33 x 10^{-7} between 0 and 300° C.) gives it a better than fighting chance with the temperatures encountered in a wide range of design problems.

And certainly of importance, the fact that countless customer-conceived projects have *proved* its profit worth.

We recommend for your reading a copy of Bulletin B-83, "Properties of Selected Commercial Glassware." Within the 14 pages of this unpretentious volume you'll find detailed, for a number of our glasses (No. 7740 included), data on mechanical properties, thermal stresses, heat transmission, and electrical and chemical characteristics. Free. Much easier with the coupon.

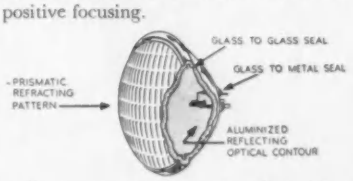
Stray rays . . . the care and handling thereof

Selective maneuvering of rays in the visible spectrum has traditionally been one of the roles that glass plays with considerable success.

Now comes another improvement in this field—one that adds comfort and safety to your motoring and, conceivably, some valuable facts to your files on glass utility. It's the new sealed-beam headlight which reduces the hazards of driving at night and in the fog.

The glass lens and reflector of the new headlight, sealed together hermetically, are designed to reduce stray rays, to concentrate more light—further ahead on the high beam and to the right of the road on the low beam.

Sounds like a simple achievement, but it took several years to accomplish and involved significant contributions of automotive, lighting, and Corning glass engineers working together on lens design, reflector design, and filament design. Corning now makes these prismatic lenses and the reflectors for several headlight manufacturers, one of whom even includes three aligning knobs on his lens, which contribute to easier and more positive focusing.



The new sealed-beam headlight illustrates how you can engineer glass to maneuver light into places where it does the most good. It also illustrates high perfection in hermetic sealing—glass-to-glass and glass-to-metal. The sealed-beam headlight is as airtight as a lamp bulb.

You can glean more about the nature and extent of engineered glass accomplishments, in *many* fields, from an attractive little primer called "Glass and You." We'll gladly send you a copy—free.

Or, Bulletin B-84: "Manufacture and Design of Commercial Glassware." Contents follow the title, offering suggestions for matching design to known advantages (as well as limitations) of various processes. The coupon will bring them to your drawing board or desk.

The big payoff?

Here's a quiz that may get you prizes galore in the form of money made (or saved). This is a matching game, aimed at showing you how one just-right Corning glass handles a difficult problem.

Write the number of the appropriate glass in the box following each description.

Protects light-sensitive substances from wayward and annoying angstroms. ☐

Conducts electricity and provides uniform heating surface. ☐

Protects against radiation effects as effectively as concrete; is nonbrowning; has density of 3.3. ☐

Can be used with intermittent temperatures to 1200° C.; has thermal coefficient of expansion of 8 x 10^{-7} per °C. ☐

Absorbs visible light from tungsten filament (2700° K.) but transmits infrared. ☐

1. VYCOR brand Glass No. 7910
2. Low Actinic Glass
3. Corning Code No. 8362 Glass
4. Corning E-C Glass
5. VYCOR brand Glass No. 7950

Correct answers: 5, 1, 3, 4, 2

And that's just a start. There's also ribbon glass that outperforms mica; glass that's brick-wall thick or eggshell thin; glass that handles metal-eating acids without ill effects; glass that copes with almost any form of radiant energy—glass that improves performance of and often adds beauty to many, many, many products.

Jot down your most vexing problem and we'll let you know if one of our glasses can help you solve it.

CORNING GLASS WORKS, CORNING, N. Y.

Corning means research in Glass

Precision Metalsmiths casts this valve as a pressure-tight unit in a beryllium copper alloy at the unbelievably low cost of $4.90.

Figure what it would cost—at your overhead—to produce, handle and stock the six brass, copper and steel parts that formerly went into this assembly. Then add fabrication costs, with an allowance for leaker-rejects that showed up all too frequently.

We can't promise you savings like this, of course. But the expendable pattern process gives product designers a free rein; your men *imagine* what they'd like to have and we cast it for them. Many machining and assembly operations can be eliminated and, often, parts are made in alloys that can't be machined—a fraction of an ounce up to 10 pounds.

Say "when" you're worried about high costs

and we'll send you this free book

PRECISION METALSMITHS, INC., 1079 East 200th St., Cleveland 17, Ohio

pour yourself an assembly with

PRECISION METALSMITHS INC.

INVESTMENT CASTINGS

industrial lamp guards with phenolic, wood or rubber handles; service lights in a wide variety of styles in medium and large sizes. McGill Mfg. Co., Inc., Valparaiso, Ind.

Circle 113, inside back cover

Rheostat Potentiometers—Bulletin A-3, 4 pp, gives data on construction, specifications, ratings, outline drawings of switches, shafts. locating lugs, nuts. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.

Circle 114, inside back cover

Hoses, Fittings, Couplings—Catalog 200, 64 pp, provides data on fluid line problems encountered by designers of machine tools, trucks, construction equipment, engines, farm equipment and other industrial products, Aeroquip Corp., 300 S. East Ave., Jackson, Mich.

Circle 115, inside back cover

Permanent Magnets—Manual 5-R, 11 pp, discusses: (1) Cast magnets—Alnico I, II, III, IV, V, VI, XII; (2) Sintered magnets—Alnico II, IV, V and VI, Indalloy and Indox; (3) Ductile magnet—Cunife I and Cunico; and (4) Formed magnets—chrome and cobalt steels. A chart summarizes characteristics, application and design factors, material characteristics, manufacturing methods and shape limitations of each material. Indiana Steel Products Co., Valparaiso, Ind.

Circle 116, inside back cover

Shell-Molded Castings—Brochure 205, 12 pp, provides tables of available alloys and their compositions. Electric Steel Foundry Co., 2141 N. W. 25 Ave., Portland, Ore.

Circle 117, inside back cover

Silicon Rectifiers—Booklet, 8 pp, describes six types of rectifiers. Sarkes Tarzian, Inc., 415 N. College Ave., Bloomington, Ind.

Circle 118, inside back cover

Gearmotors—Bulletin E-2408, 8 pp, describes line of gearmotors available incorporating new NEMA motors and redesigned gearheads. Reliance Electric & Mfg. Co., 1088 Ivanhoe Road, Cleveland 10, Ohio.

Circle 119, inside back cover

Heat Exchangers—Bulletin, 4 pp, contains dimensions, drawings, weights, capacities of fixed bundle heat ex-

(Continued on page 360)

Your choice of normal or low starting current...

with Performance-Rated

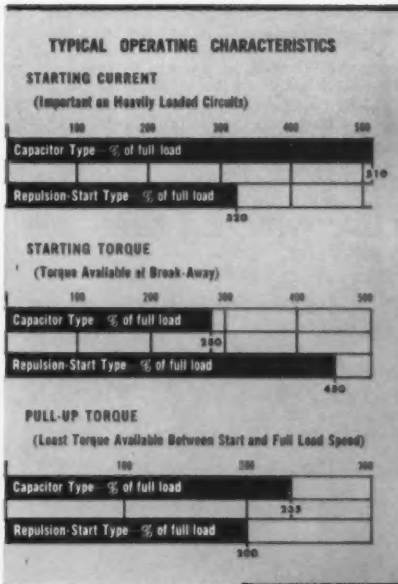
Century

HIGH TORQUE, SINGLE-PHASE MOTORS

Capacitor Motors... ½ to 20 H.P. provide high starting torque, high pull-up torque and require normal starting current. They are available in drip proof, dust proof and explosion proof enclosures.

Even if you have severe starting current limitations, you can select the torque you need for sure starts and smooth pull-up to speed from the Century Performance-Rated Single-Phase line (see bar chart below for operating characteristics of two types of Century Single-Phase Motors).

Whatever Your Motor Job . . . there's a Century Motor Performance-Rated to handle it with top effectiveness. Contact your nearby Century branch office or Authorized Distributor.



Repulsion Start, Induction Motors (type RS)... ½ to 7½ H.P. provide very high starting torque, yet require unusually low starting current. They are available in drip proof and splash proof enclosures.

Performance-Rated© Motors ⅛ to 400 H.P.

CENTURY ELECTRIC COMPANY

CE-32

1806 Pine Street, St. Louis 3, Missouri • *Offices and Stock Points in Principal Cities*

MICROHONING*

Generates . . .

ACCURATE, ROUND, STRAIGHT SURFACES

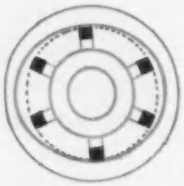
Truly round, straight surfaces are generated by the application of fundamental principles on which the Microhoning process and equipment design are based:

The combined reciprocating and rotating motion of the tool act on the full length of the bore on every stroke.

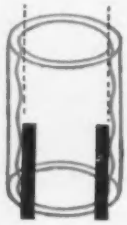
The self-dressing abrasive assures sharp grits and cutting at all times.

The tool and bore automatically align themselves.

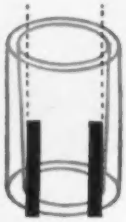
The feed-out of the tool is positive with equal pressure in all directions from the center line.



All out-of-roundness is removed by the expanding abrasive "cylinder" formed by the rotating tool. Only the tight areas are abraded until all areas have the same radius from the axis.



Wavy or snaky surfaces are made straight by the long abrasive sticks shearing off the crests of the waves.



In tapered bores the abrasives cut only in the tight area until the cylinder has the same diameter throughout its full length.

ACTUATING LEVER

Steel Forging • 58 to 60 Rockwell "C"

Bore out-of-round and tapered .0015 to .0025 inch.

Microhoning reduces error to less than .00015 inch

Removing approx. .005 inch stock

Production—130 pieces per hour

Machine—Model 705-2 Hydrohoner

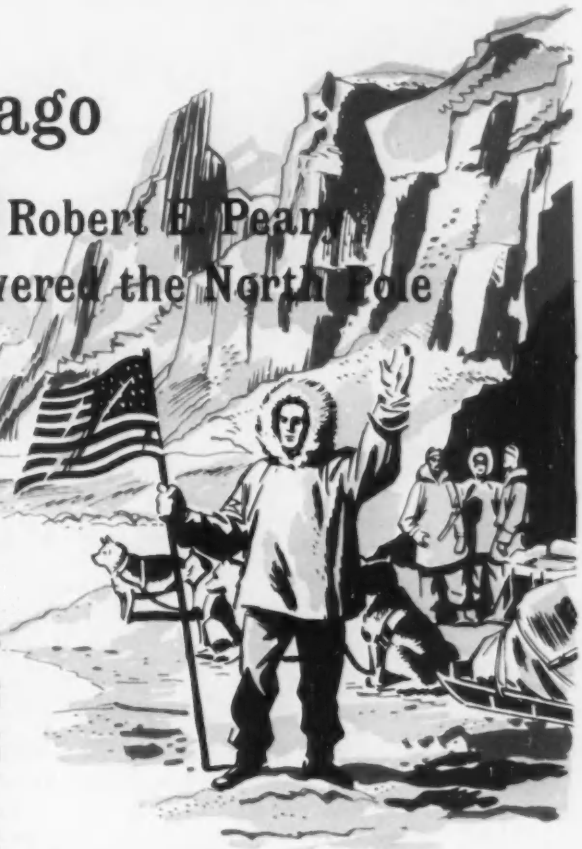
***MICROHONING** = Stock Removal + Geometry + Size Control + Surface Finish

MICROMATIC HONE CORPORATION

8100 SCHOOLCRAFT AVENUE • DETROIT 38, MICHIGAN

75 years ago

and 28 years before Robert E. Peary discovered the North Pole



Koven

was making individualized equipment parts

Progress requires challenge — challenge that invigorates man's sense of exploration—that incites him to discover and to expand in the fields of technology and geography.

In 1881 the KOVEN Corporation came into being precisely to accept this kind of challenge — to instigate newer and more appropriate means of serving and developing in the equipment industry.

Since that time KOVEN has continuously improved its standards in manufacturing specialized equipment parts, until today — with its considerable increase in efficiency — it produces these parts often more rapidly and more economically than the equipment manufacturer himself.

For individualized equipment parts tailored to suit your exact needs, call or write for a consultation with a trained KOVEN representative, and send for Bulletin #550. There's no obligation.

Tank Made of Steel

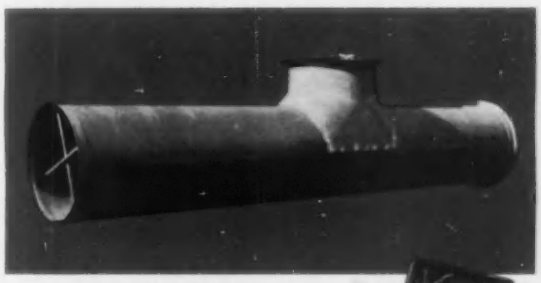
SPECIALISTS IN INTRICATE FABRICATION USING:

• STAINLESS STEEL • ALUMINUM
• MONEL • NICKEL • INCONEL
• ALL CLAD MATERIALS

Fabrication to all A.S.M.E. Codes

X-RAY INSPECTION FOR QUALITY CONTROL

KOVEN equipment in all metals and alloys includes: High pressure vessels built to A.S.M.E., A.P.I. Codes; extractors; mixers; stills; kettles; tanks; stacks; breechings; hot transfer lines; light and heavy fabricated piping and plate exhaust ducts. Shop and field erected storage tanks to 2 million gallons. High vacuum testing on liquid oxygen storage tanks.

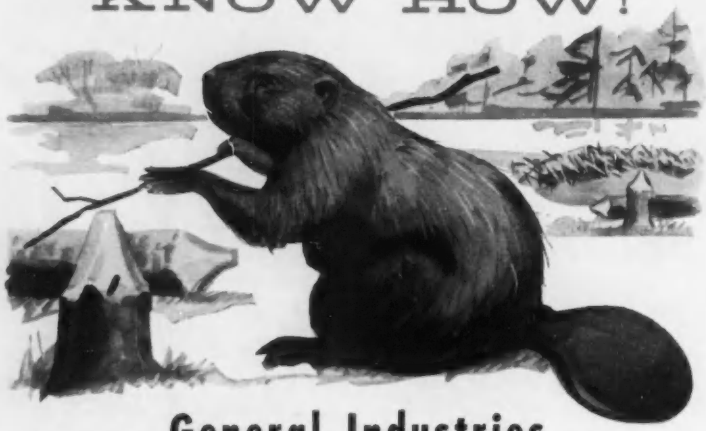


Steam, Water and Gas Piping

Koven *FOR INDIVIDUALIZED EQUIPMENT SINCE 1881*

L. O. KOVEN & BRO., INC. • 154-C OGDEN AVE., JERSEY CITY 7, N. J.
PLANTS: JERSEY CITY, N. J. • DOVER, N. J. • TRENTON, N. J.

ENGINEERING KNOW HOW!

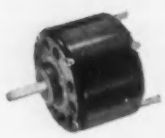


General Industries
FRACTIONAL HP. MOTORS

1/40 HP. to 1/1100 HP.

Engineering Know How . . . means efficient performance and longer life . . . a prime factor in every GI FRACTIONAL HP MOTOR.

■ *Engineering Know How* is just one of the reasons why so many original equipment manufacturers have come to rely on GI. They know that a GI 1/40 hp to 1/1100 hp motor will "hit the specs" every time; there's no "almost" about a GI fractional hp motor. Manufacturers like General Industries' free design consultation service and right-on-the-dot deliveries, too. When you have a fractional hp requirement, you'll find that your best bet is to . . . specify GI!



MODEL B
4-pole, 4-coil shaded pole AC Induction Type

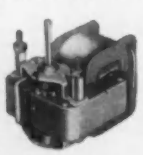
MODEL A
2-pole, shaded pole AC Induction Type

MODEL C
2-pole, shaded pole AC Induction Type

MODEL E
4-pole, shaded pole AC Induction Type

MODEL O
2-pole Capacitor Reversible Type AC only (for 6, 12, or 24 volts)

MODEL D
4-pole, 4-coil shaded pole AC Induction Type



MODEL F
2-pole, shaded pole AC Induction Type

Write for Complete Specifications and Quantity - Price Quotations!

THE GENERAL INDUSTRIES CO.

DEPARTMENT GM • ELYRIA, OHIO

changers designed for engines, machine tools, processing machinery, other industrial equipment. Yates-American, Beloit, Wis.

Circle 120, inside back cover

Spherical Bearings and Rod Ends—Bulletin 555, 16 pp, contains data on capacities, dimensions, construction, installation details, Sealmaster Bearing Div., Stephens-Adamson Mfg. Co., Aurora, Ill.

Circle 121, inside back cover

Hydraulic Torque Converter—Bulletin 135-D, 15 pp, describes three-stage engine converter. Twin Disc Co., Racine, Wis.

Circle 122, inside back cover

Gages—Catalog 18-12-1604, 8 pp, describes gages for pressure, temperature, vacuum, fuel, electrical measurement, as well as safety panels, warning devices. Stewart-Warner Corp., 1826 W. Diversey Pkwy., Chicago 14, Ill.

Circle 123, inside back cover

Pressure-Filled Metal O-Ring—Folder, 6 pp, describes O-rings filled with inert gas under pressure. Various metals are used. Pressure in the ring is normally about 600 psi. Standard sizes range from 1 to 96 in. OD. Darcoid Co., Inc., 145 Sixth Ave., New York 13, N. Y.

Circle 124, inside back cover

Variable Speed Reducer—Catalog, 11 pp, describes principles of operation of infinitely variable speed transmission with output speeds from true zero to ¼ input speed. Standard models are shown with optional variations, typical applications and installation suggestions, dimensions and ratings. Revco, Inc., 2 E. Franklin Ave., Minneapolis 4, Minn.

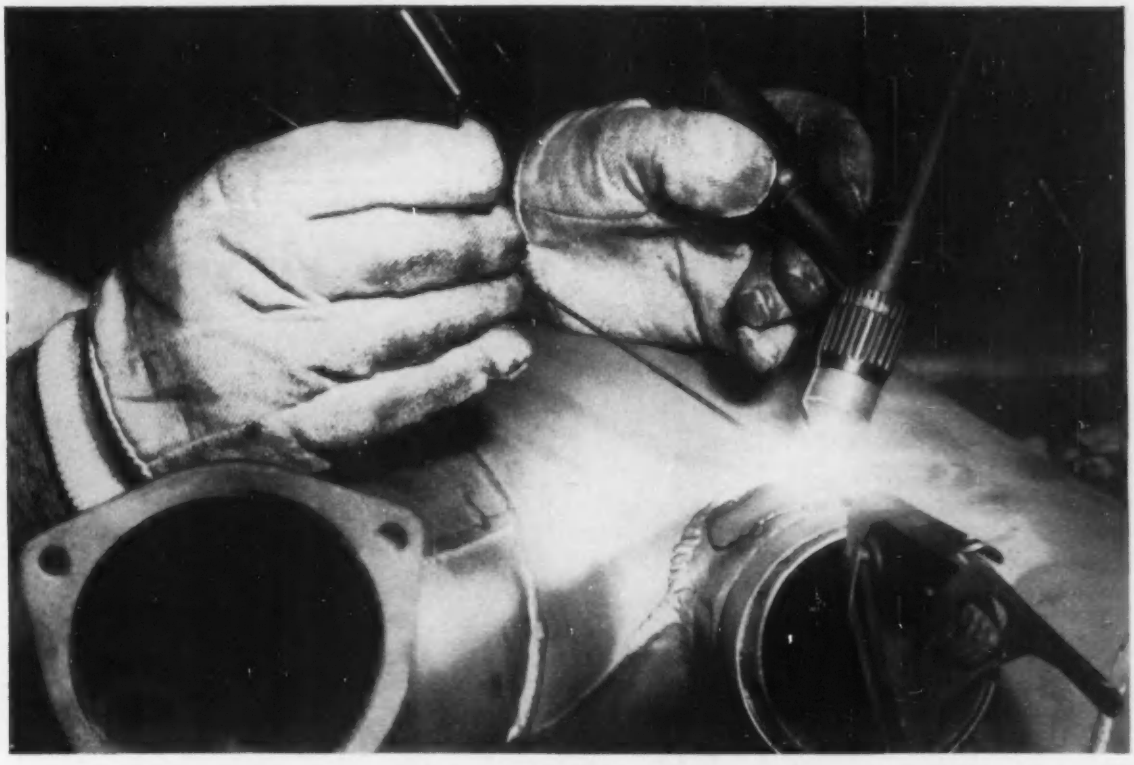
Circle 125, inside back cover

Stainless Strip—Brochure, 32 pp, gives recommended applications, general description, chemical, physical and mechanical properties, corrosion resistance. Superior Steel Corp., Carnegie, Pa.

Circle 126, inside back cover

Aluminum Extrusions—Booklet, 24 pp, gives detailed information on two new 8,000 ton presses at the company's Halethrope, Md., heavy press plant: how they operate, their manu-

(Continued on page 364)



It took only 10 min. to repair this aircraft manifold by HELIARC welding—the savings amounted to $1,485 over the price of a new manifold.

"HELIARC" WELDING SAVES 99%

Of New Part Cost...

Throughout industry, HELIARC welding is being used to make repair welds in all types of commercially fabricated metals—at a fraction of new part cost. In the repair operation shown here, a 1/16-in. thick stainless steel aircraft engine exhaust manifold was HELIARC welded and made good as new for $15... the cost for a new manifold would have been $1,500.

Whether used for fabricating or repairing, HELIARC welding is ideal for joining light gage metals. Welding can be done in all positions on all types of joints—with portable manual, and semi-automatic equipment. Mechanized setups are also available.

In HELIARC welding there is no slag, spatter, or smoke. The weld area is argon-gas-shielded from the harmful effects of the atmosphere, and the operator can see and control the weld puddle at all times.

HELIARC welding may be the answer to *your* fabricating and repair problems. Find out—call or write your local LINDE Representative today.

Linde Air Products Company
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street UCC New York 17, N. Y.
Offices in Other Principal Cities
In Canada: LINDE AIR PRODUCTS COMPANY
Division of Union Carbide Canada Limited, Toronto

The terms "Linde" and "Heliarc" are registered trademarks of Union Carbide and Carbon Corporation.

Linde
Trade-Mark

HOWELL MOTOR BRIEFS

Quick facts for those who apply and specify electric motors

New Stator Design is a Motor Life Saver!

One sure way to save years of motor life is to provide a better means of removing excess internal heat. That's what has been accomplished by the new stator lamination design developed for the Howell Series 100 motors.

Instead of the conventional smooth outer surface, this stator has wide ventilation slots in its circumference. With the dividing "fins" fitted against the motor frame, air passages are created that put 50% more stator heat transfer surface in direct contact with the flow of fan-driven air.

Copper-clad rotors shed heat faster, too

Rotor slot bars and end discs are a bonus feature of all Howell motors. Note below right the much greater thermal conductivity of copper, as compared to aluminum, the metal in common use for cast rotors today.

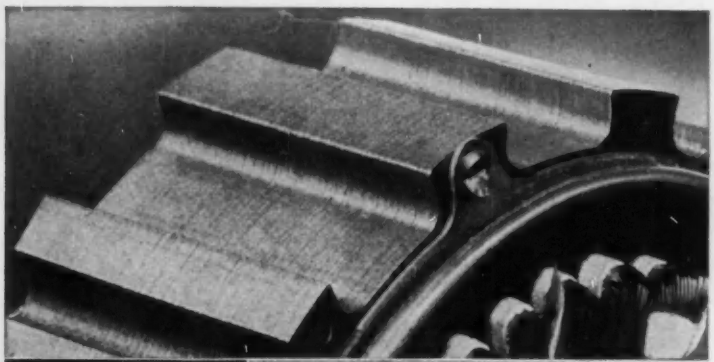
Significantly better heat dissipation is one of the reasons why Howell engineers, in designing for the new frame sizes, came up with such an outstanding group of motors in the new Series 100. They are not only smaller and lighter, they're cooler running than their horsepower equivalents in the old frame sizes.

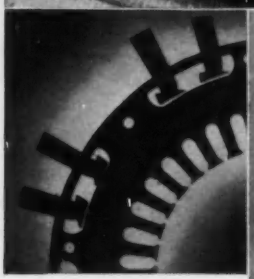
Why not go modern in motors?

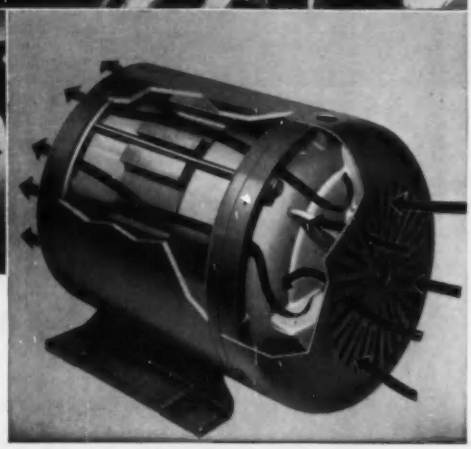
Fact is, you really can't afford to pass up the Howell Series 100 Rerated motors without investigating their potentials for your machine modernization programs. They give you space savings, weight savings and new, sleek good looks—along with construction features like these: Mylar-lined slot insulation, fully protected cartridge type bearings, resilient steel frames and mounting feet, and permanently position-identified leads. These are a few of the gains; let us tell you about the rest.

Series 100 enclosures: totally enclosed fan cooled, open drip-proof, splash-proof and weather protected, sanitary, explosion-proof, and totally enclosed non-ventilated.

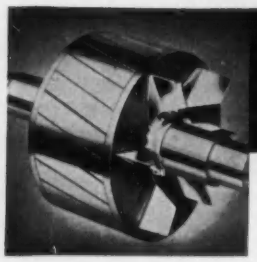
Write for new Bulletin N-100-R

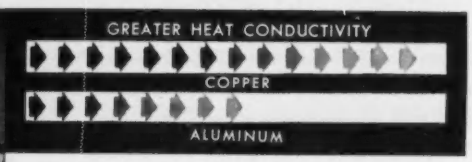






Illustrations above and at right show the first real advancement in motor ventilation in years—made possible by the slotted stator design of the new Howell Series 100 motors.





The thermal conductivity (K factor) of copper is 91% greater than that of aluminum. Copper's electrical resistivity is 35% less. Two good reasons for Howell's use of copper-clad rotors in Howell Series 100 motors of *all* horsepowers.

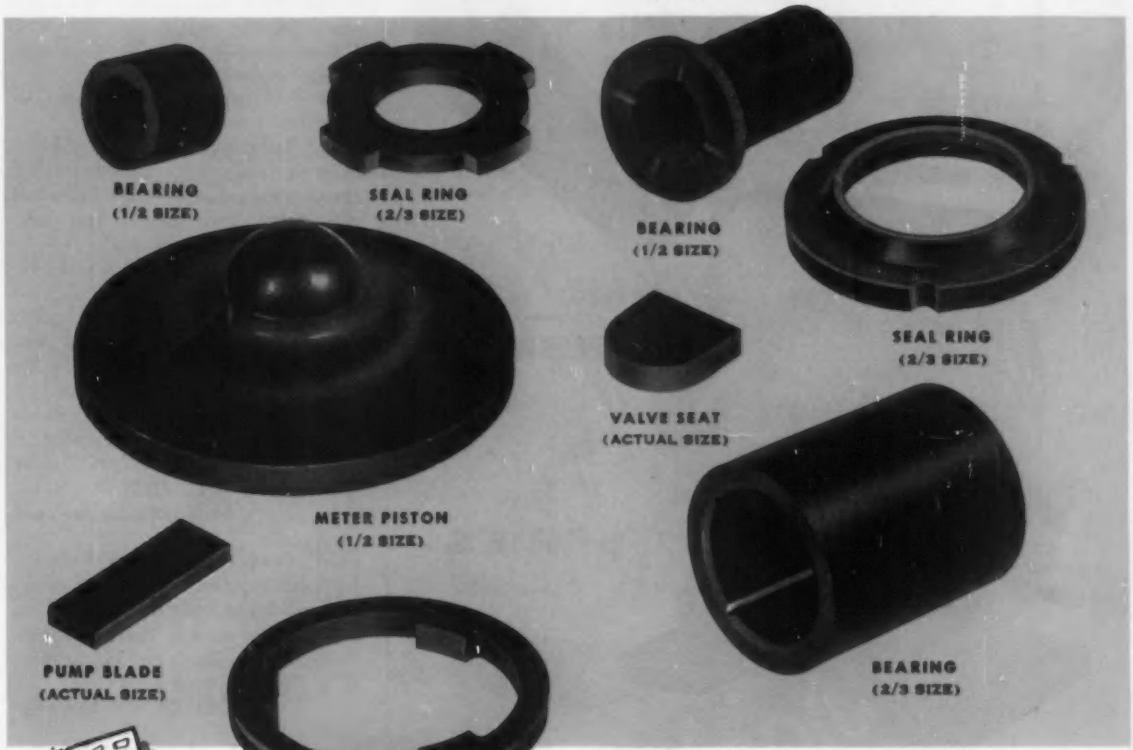
HOWELL MOTORS

HOWELL ELECTRIC MOTORS COMPANY, HOWELL, MICHIGAN

PRECISION-BUILT MOTORS FOR INDUSTRY SINCE 1915

. . . the solution to your Lubrication problem is here . . . PUREBON

Carbon-graphite especially designed for mechanical applications.



For complete information about PUREBON. Write for Bulletin 52

Purebon is the designer's solution to many knotty problems involving sliding or rotating parts where lubrication is difficult and sometimes impossible. Purebon parts are molded or machined exactly to our customers' specifications here in our own plant, under our close supervision and inspection. *Because of the diversified characteristics of Purebon, applications are limited only by the designer's imagination.* If you have a problem involving insufficient lubrication at critical points of friction, our design engineering department will be happy to work with you toward its swift and successful solution.

PUREBON'S PROPERTIES

1 **MOLDED TO SIZE—FOR MANY APPLICATIONS**
Tolerances of approximately 1½% of dimension required for molding most shapes.

2 **SELF-LUBRICATING—OR BY THE MATERIAL HANDLED**
Varies with grade of Purebon.

3 **STRONG AND TOUGH**
Transverse strength varies from 4,000 to 13,000 lb./sq. in. according to grade.

4 **READILY MACHINABLE**
Tolerances as close as .0005 can be maintained where required.

5 **CHEMICALLY INERT—NON-TOXIC**
Resistant to attack by chemicals of all kinds, used in food handling and processing equipment.

6 **HIGH TEMPERATURE APPLICATION**
Most Purebon grades will operate efficiently in temperatures up to 700°F in air or much higher in neutral or reducing atmosphere.

Leaders for over 40 YEARS in PURE CARBON PRODUCTS

PURE CARBON CO., INC.
450 HALL AVENUE
ST. MARYS, PENNSYLVANIA

Something NEW has been added to Winsmith speed reducers...it's the new "C" Series with five new features that make every reducer in the line your best dollar for dollar buy. Both input and output shafts are larger and stronger, larger tapered roller bearings are used throughout, contoured fins at base give secure, vibrationless mounting and housings are designed for greater heat radiating capacity. *Net result?* Greater performance, greater stamina, greater dependability.

The "C" Series is comprised of 108 models in both single and double reduction units—there is a unit to meet every speed reducer need—*with greater value for your horsepower dollar.*

WINSMITH SPEED REDUCERS

GET THE FACTS:
on the complete "C" Series...write for Winsmith's new catalog. Contains complete engineering selection information for each reducer described.

WINSMITH, INC. 111 Eaton Street, Springville, (Erie County), N. Y.

facturing capacities, as well as extrusion design suggestions. Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, Calif.
Circle 127, inside back cover

Self-Tapping Inserts—Booklet 11 pp, describes the insert and its uses. Groov-Pin Corp., 1125 Hendricks Causeway, Ridgefield, N. J.
Circle 128, inside back cover

Speed Reducers—Bulletin 450, 52 pp, includes horsepower rating tables, specifications, dimensions, weights and other data. Farrel-Birmingham, Co., Inc., Ansonia, Conn.
Circle 129, inside back cover

O-Rings—Catalog 5701, 12 pp, contains cross reference charts of size numbers with dimensional data for O-rings for sealing applications and condensed charts of maker's standard synthetic rubber compounds. Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio
Circle 130, inside back cover

Fluid Power Components—Bulletin, 4 pp, has cross-section views of cylinders and valves and data on both air and hydraulic models. Rivett Lathe & Grinder, Inc., Brighton 35, Boston, Mass.
Circle 131, inside back cover

Research and Development—House organ, 12 pp, plans to report on activities in automotive, aircraft, electronic and other fields. First issue no longer available. Thompson Products, Inc., 23555 Euclid Ave., Cleveland 17, Ohio.
Circle 132, inside back cover

Epoxy Adhesives—Bulletin, 6 pp, describes group of adhesives providing high sheer strengths at 200 to 250 F. Furane Plastics, Inc., 4516 Brazil St., Los Angeles 39, Calif.
Circle 133, inside back cover

Aluminum Mill Products—Booklet, 24 pp, offers data on aluminum alloys, forms, mechanical and physical properties, applications, fabricating and finishing and availability. Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, Calif.
Circle 134, inside back cover

Product Literature Directory—24 pp, has an alphabetically arranged descrip-
(Continued on page 368)

Use Laminated Plastic Parts?

Write for this FREE catalog today

Unless you have extensive know-how and complete facilities for fabricating laminated plastics parts you'll do better – much better! – by letting MICO produce your precision parts for you from LAMICOID®.

MICA INSULATOR COMPANY
761 Broadway • Schenectady 1, New York
Subsidiary of Minnesota Mining & Manufacturing Co.

For complete information, mail this coupon now.

MICA INSULATOR COMPANY
Department 761 Schenectady 1, New York

Please send me a free copy of "Save Time, Money, Trouble with LAMICOID Fabricated Parts."

Name_____
Title_____
Company_____
Address_____
City_____ Zone____ State_____

Save time...

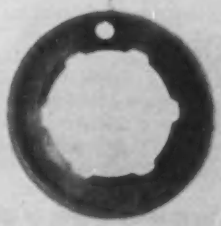
...trouble...money

with

FABRICATED

PARTS of

LAMICOID®
PLASTIC LAMINATES



MICA INSULATOR COMPANY SCHENECTADY 1, NEW YORK
Subsidiary of Minnesota Mining and Manufacturing Company

WOULD A TOUGHER STEEL CHANGE YOUR PLANS?

New Lukens "T-1" steel has three times the yield strength of carbon steel—cuts equipment weight, cuts costs!

■ Here's a new alloy steel with unusual resistance to abrasion, impact and atmospheric corrosion . . . that *stays* tough at temperature extremes. And where extra strength is required from plate steel, Lukens "T-1" Steel makes possible substantial overall savings and material.

If you plan or purchase bridge parts, construction machinery or *any* general industrial equipment, check Lukens "T-1" steel *now!* Its toughness and strength can cut material costs—you'll often need less to begin with. Its rugged on-the-job performance can reduce maintenance expense and replacement costs — often provide longer service life!

The latest addition to a complete line of carbon, alloy and clad steels, this all-purpose material is obtainable from Lukens in the widest range of plate sizes available anywhere! Whether you want specific product information or the best ways to make the most of it, write to Manager, Marketing Service, 849 Lukens Building, Lukens Steel Company, Coatesville, Pennsylvania.

Whatever your plans—now's the time to change to . . .

LUKENS "T-1" STEEL

LUKENS

THE NEWEST IN A COMPLETE LINE OF ALLOY STEELS
LUKENS STEEL COMPANY, COATESVILLE, PENNSYLVANIA

NOW AVAILABLE!

SUPER-RUGGED!

ADVAC

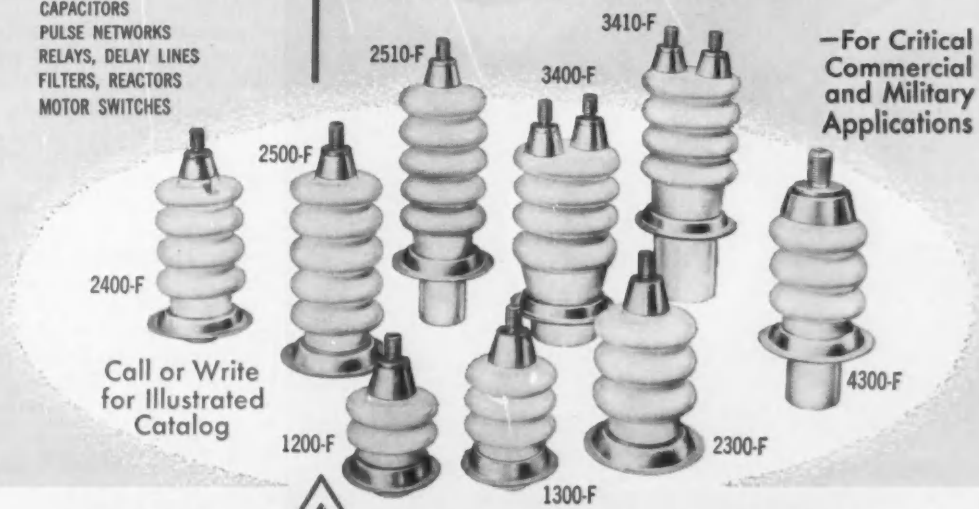
HIGH VOLTAGE TERMINALS

- **Pure silver brazed for higher temperature service**
- **Helium mass spectrometer tested for vacuum-tightness**
- **High mechanical strength and thermal shock resistance**
- **Adaptable for soft-soldering, brazing or welding**

New ADVAC High Voltage Terminals withstand operating temperatures of over 1000°F. They have been service-proven in a wide range of applications where severe environmental conditions, including both mechanical and thermal shock, are encountered. ADVAC super-rugged high voltage terminals are available in nine economical standard types that meet most requirements. For special applications, custom terminals can be produced to your exact specifications.

Specify ADVAC High Temperature Ceramic-to-Metal Seals for:

- JET ENGINE THERMO-COUPLE SEALS
- FIRE DETECTION AND TEMPERATURE CONTROLS
- EXPLOSION PROOF ASSEMBLIES
- REFRIGERATION COMPRESSOR SEALS
- KLYSTRON OUTPUT WINDOWS
- T-R TUBE WINDOWS
- IGNITION INSULATOR BUSHINGS
- VACUUM TUBE CLOSURES
- HEATING ELEMENT TERMINATIONS
- NUCLEAR ENERGY EQUIPMENT
- IMMERSION HEATER SEALS
- POWER CABLE END SEALS
- CHEMICAL RESISTANT INSULATORS
- HEAVY-DUTY TRANSFORMERS
- CAPACITORS
- PULSE NETWORKS
- RELAYS, DELAY LINES
- FILTERS, REACTORS
- MOTOR SWITCHES



—For Critical Commercial and Military Applications

Call or Write for Illustrated Catalog

DIVISION OF GENERAL CERAMICS CORPORATION

ADVANCED VACUUM PRODUCTS · INC

18-22 Liberty Street, Stamford, Connecticut—Telephone: Davis 4-2148

HIGH TEMPERATURE, VACUUM TIGHT CERAMIC-TO-METAL SEALS FOR THE ELECTRONIC INDUSTRY

EXPAND METAL • SHRINK METAL • ROLL-FORM METAL

case in point...

shown:

A production sequence
using GROTNES machines only
(except for welding).

Some of Many Products Wholly or Partially Processed on GROTNES Equipment:

Electric Motor Housings • Automotive Tire Rims
Heater Tanks • Jet Engine Parts • Metal Containers
Furnace Parts • Washer and Dryer Tubs

GET THIS FACT BOOK
explaining the GROTNES
method of cold-forming metals.

GROTNES
MACHINE WORKS, INC. Dept. S.
5454 N. Wolcott Ave., Chicago 40, Ill., U.S.A.

tion of company products and their descriptive literature. Allis-Chalmers Mfg. Co., 1002 S. 70 St., Milwaukee, Wis.

Circle 135, inside back cover

Machine Tool Limit Switch–Catalog 955, 10 pp, has purchasing and specification data on switches, including information on housings, wiring diagrams, ampere ratings, operating data and electrical characteristics. R. B. Denison Mfg. Co., 102 St. Clair Ave., N. W., Cleveland 13, Ohio

Circle 136, inside back cover

Magnetic Chucks–Catalog 412, 20 pp, covers standard lines of rectangular magnetic chucks, rotary magnetic chucks, sine angle magnetic chucks, and magnetic work drivers. Taft-Pierce Mfg. Co., Woonsocket, R. I.

Circle 137, inside back cover

Nickel-Cadmium Battery–Folder, 4 pp, contains specifications on a sintered plate, nickel cadmium storage battery, made for 6 and 12-v service. Sonotone Corp., Elmsford, N. Y.

Circle 138, inside back cover

Printed Circuit Connector–Data sheet, 2 pp, gives description and specifications, plus mounting and clearance dimensions. DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle 139, inside back cover

Custom-Built Cylinders–Bulletin 79000, 6 pp, has design information and data on materials of construction used in hydraulic cylinders available for 1500, 3500 psi or higher pressures. Oilgear Co., 1578C W. Pierce St., Milwaukee 4, Wis.

Circle 140, inside back cover

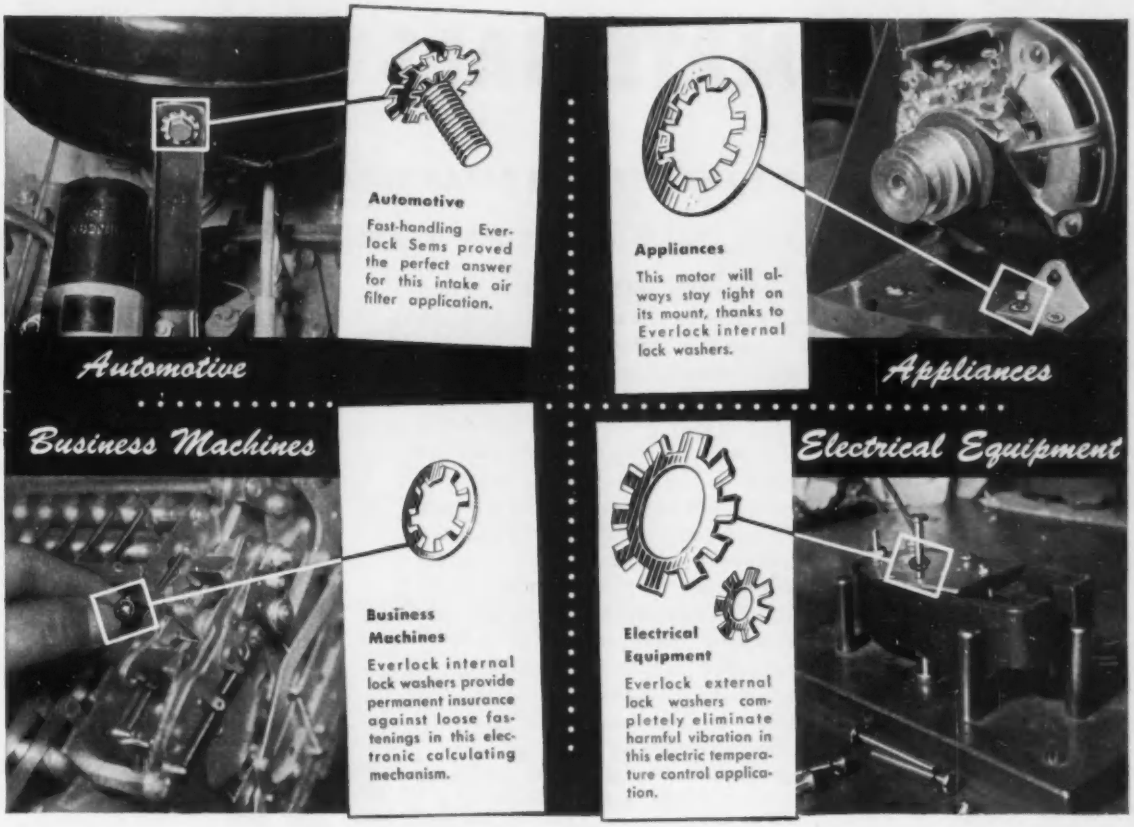
Nylon Tube Fitting–Bulletin, 4 pp, describes a lightweight nylon fitting impervious to most acids and alkalies and guaranteed not to crack or leak under normal conditions. Jaco Mfg. Co., Box 2659, Cleveland 7, Ohio

Circle 141, inside back cover

Rubber-In-Shear Mounts–Catalog RS-55, 4 pp, describes various types of vibration mountings, with load capacities ranging from 40 to 10,000 lb., together with non-walking base-plates that eliminate creep or walking and the need for lagging them to the floor.

(Continued on page 372)

lick loose fastenings...FOR GOOD!


Automotive
Fast-handling Everlock Sems proved the perfect answer for this intake air filter application.
Appliances
This motor will always stay tight on its mount, thanks to Everlock internal lock washers.
Appliances
Business Machines
Business Machines
Everlock internal lock washers provide permanent insurance against loose fastenings in this electronic calculating mechanism.
Electrical Equipment
Electrical Equipment
Everlock external lock washers completely eliminate harmful vibration in this electric temperature control application.

with low-cost *Everlock* lock fasteners

Loose fastenings mean lost business . . . leave you wide open for costly rejections and customer complaints. Yet loose fastenings are probably your easiest-to-solve problem. Simply use Everlock lock fasteners. Vibration, constant jarring, impact—all only serve to *tighten* Everlock's bulldog bite.

Whatever your product, however it's assembled —don't overlook Everlock. Stock sizes and types, or special designs lick *your* fastening problems *for good.*

Another AMF Product

Everlock

INDUSTRIAL FASTENERS

FREE SAMPLE KIT

Put Everlock lock fasteners to the test on your own products. For your free sample kit and your copy of the brand new Everlock catalog, mail this coupon.

THOMPSON-BREMER & CO.

Subsidiary of AMERICAN MACHINE & FOUNDRY COMPANY

516 North Dearborn Street • Chicago 10, Ill.

Please send me:

☐ New Everlock Catalog.

☐ Free sample kit of Everlock Fasteners.

Name _____

Title _____

Company _____

Address _____

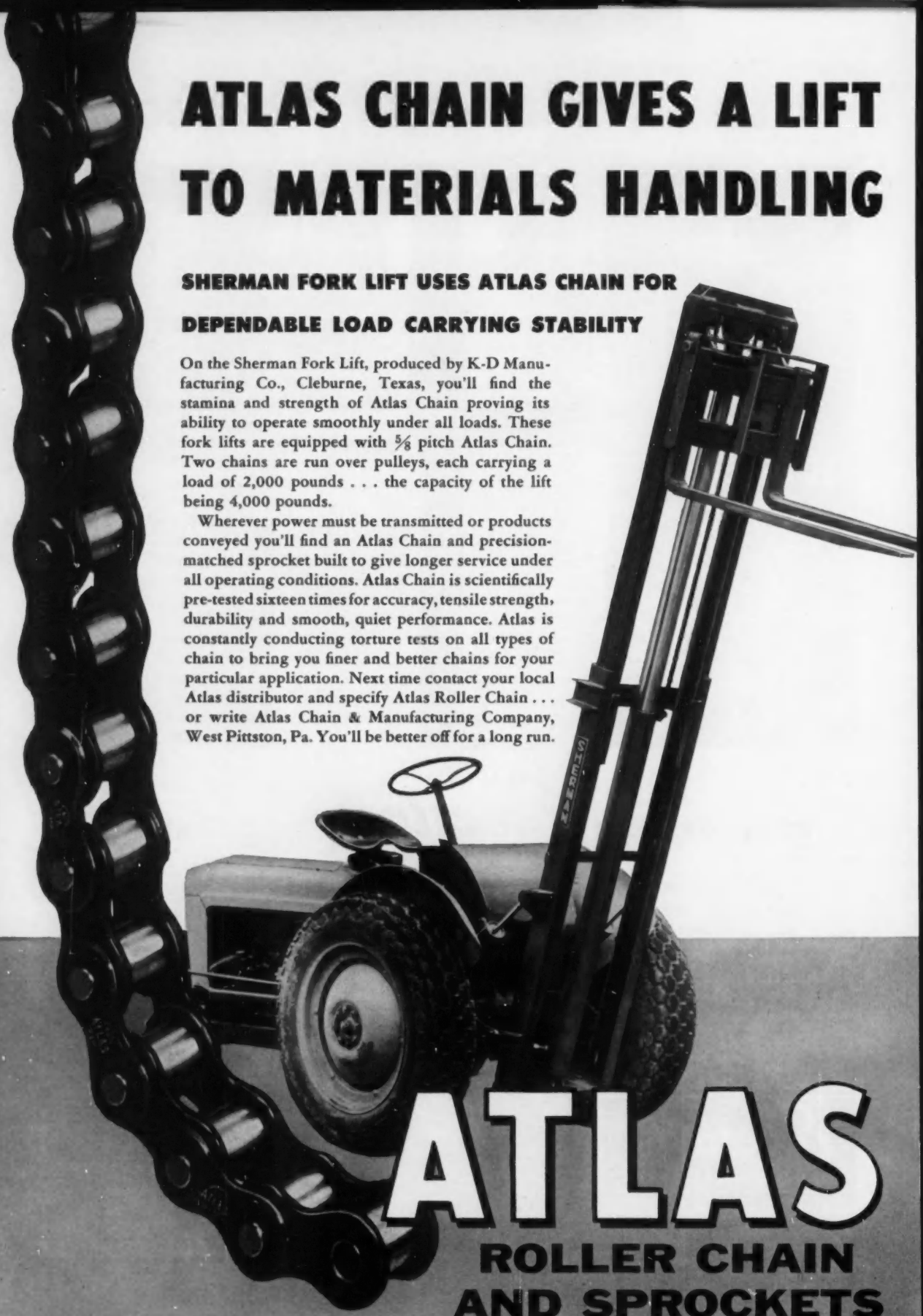
City _____ Zone _____ State _____

ATLAS CHAIN GIVES A LIFT TO MATERIALS HANDLING

SHERMAN FORK LIFT USES ATLAS CHAIN FOR DEPENDABLE LOAD CARRYING STABILITY

On the Sherman Fork Lift, produced by K-D Manufacturing Co., Cleburne, Texas, you'll find the stamina and strength of Atlas Chain proving its ability to operate smoothly under all loads. These fork lifts are equipped with 5/8 pitch Atlas Chain. Two chains are run over pulleys, each carrying a load of 2,000 pounds . . . the capacity of the lift being 4,000 pounds.

Wherever power must be transmitted or products conveyed you'll find an Atlas Chain and precision-matched sprocket built to give longer service under all operating conditions. Atlas Chain is scientifically pre-tested sixteen times for accuracy, tensile strength, durability and smooth, quiet performance. Atlas is constantly conducting torture tests on all types of chain to bring you finer and better chains for your particular application. Next time contact your local Atlas distributor and specify Atlas Roller Chain . . . or write Atlas Chain & Manufacturing Company, West Pittston, Pa. You'll be better off for a long run.



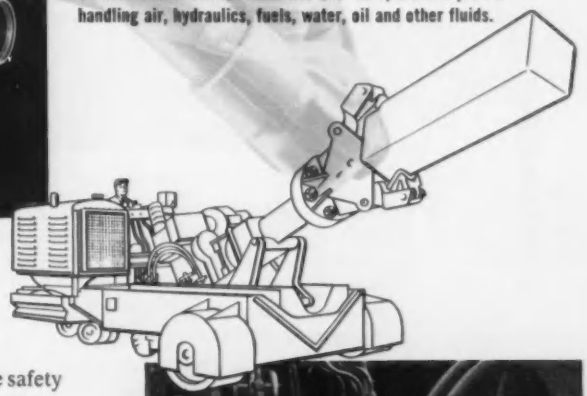
ATLAS

ROLLER CHAIN AND SPROCKETS

CHIKSAN

Works wonders with hydraulic lines

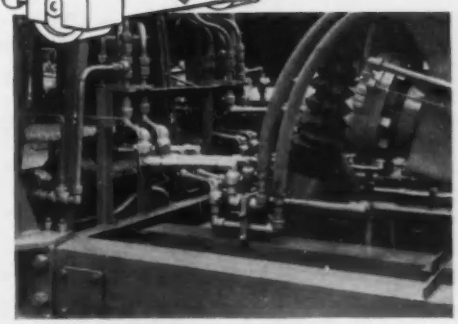
Chiksan Swivel Joints rotate full 360° in 1, 2 and 3 planes handling air, hydraulics, fuels, water, oil and other fluids.



CHIKSAN SWIVEL JOINTS

Give metal lines the flexibility of rubber with the safety and service life of steel. And with free swiveling 360° rotation, Chiksan Swivel Joints eliminate line failure due to bend radii and torsion fatigue.

Investigate Chiksan Swivel Joints for application in your plant and on your products. Their modest cost is quickly repaid in savings of down-time, replacements and maintenance.



Installed on hydraulic lines of a Salem-Brosius forging manipulator, these Chiksan Swivel Joints have been in continual service for over 3 years with no down-time to date.

CHIKSAN

A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

fmc

FOR FREE CATALOG WRITE DEPT. 174

CHIKSAN COMPANY — BREA, CALIFORNIA • CHICAGO 5, ILLINOIS • NEWARK 2, NEW JERSEY

Well Equipment Mfg. Corp. (Division) Houston 1, Texas • Chiksan Export Company • Chiksan of Canada, Ltd., Edmonton, Alta.

Giants of American instrument industry, including such firms as . . .

- Bulova Research & Development Laboratories, Inc.
- Eclipse Pioneer, Division of Bendix Aviation Corp.
- Federal Telecommunication Laboratories, Inc.
- General Electric Co.
- Sperry Gyroscope Co.

and many others think of CHATILLON, when instrument design calls for the "world's most accurate spring".

CHATILLON . . . the leading manufacturer of precision springs is particularly proud of the improved performance record of instruments using the noteworthy CHATILLON developed temperature-compensated alloy "Iso-Elastic". The hysteresis error of this remarkable spring is less than .05% of deflection. Drift does not exceed .02% of deflection in 5 minutes. These characteristics plus temperature compensation insure the ultimate in precision spring production.

CHATILLON makes Extension, Spiral, Torsion, Compression and Form Springs of Iso-Elastic material, as well as springs of all conventional alloys.

To find out how "the World's Most Accurate Spring" can better your product and for engineering bulletins, write CHATILLON SPRING DIVISION.

*U.S.A. Pat. No. 2174171

JOHN CHATILLON & SONS
85 CLIFF STREET, NEW YORK, N. Y.
Manufacturer of Precision Springs and Measuring Apparatus Since 1835

Catalogs and Bulletins . . . . . continued

Finn & Co., Inc., 200 Central Ave., Hawthorne, N. J.
Circle 142, inside back cover

Chemical Rubber Products—Booklet, 7 pp, touches on composition and manfacture of a synthetic rubber, outlines characteristics and shows by examples how these properties have proved advantageous to users of hose, belting, seals, coatings and other products. E. I. du Pont de Nemours & Co., Wilmington 98, Del.
Circle 143, inside back cover

Selenium Rectifiers—Bulletin M1, 8 pp, includes physical and electrical characteristics charts together with diagrams giving the exact dimensions of each type of rectifier. Federal Telephone and Radio Co., 100 Kingsland Road, Clifton, N. J.
Circle 144, inside back cover

Heating Elements—Booklet, 8 pp, describes flexible heating units made of resistance coil grids molded within sheets of insulation material. Electroflex Heat, Inc., 516 Asylum St., Hartford 5, Conn.
Circle 145, inside back cover

Potentiometer—Data sheet, 4 pp, describes potentiometers with resistance ranges from 10 to 100,000 ohm, linearity percentage for both styles of mounting, functional and electrical angles with and without stops, dissipation ratings, torque in.-oz fractions, ganging information, sizes and weights. Waters Mfg., Inc., 4 Gordon St. Waltham, Mass.
Circle 146, inside back cover

Carbon and Alloy Steels Compared—Booklet, 12 pp. Of the nine graphs included in the booklet, the first plots allowable stress against temperature for the various carbon and alloy steels under discussion. The remaining eight graphs are paired according to maximum service temperatures in increments of 100 from 650 to 950 F. Lukens Steel Co., Coatesville, Pa.
Circle 147, inside back cover

Fire-Resistant Pulleys—Folder, 4 pp, describes pulleys which stop combustion when flame is removed. This non-after glow characteristic helps prevent secondary fires. Includes cut-away diagrams of ball bearing pulleys, standard control pulleys and complete spec-

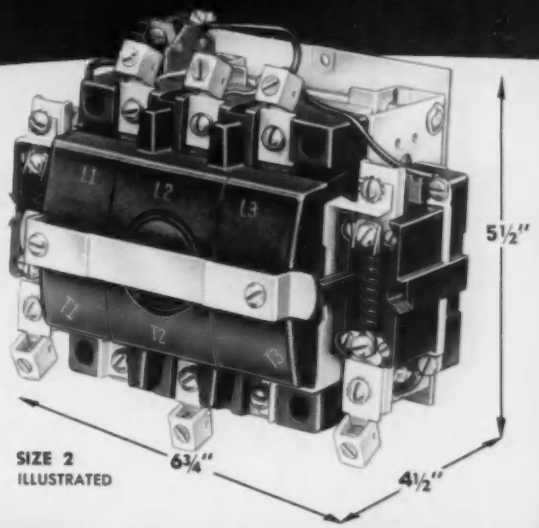
(Continued on page 375)

BY FAR THE *Finest* EVER BUILT

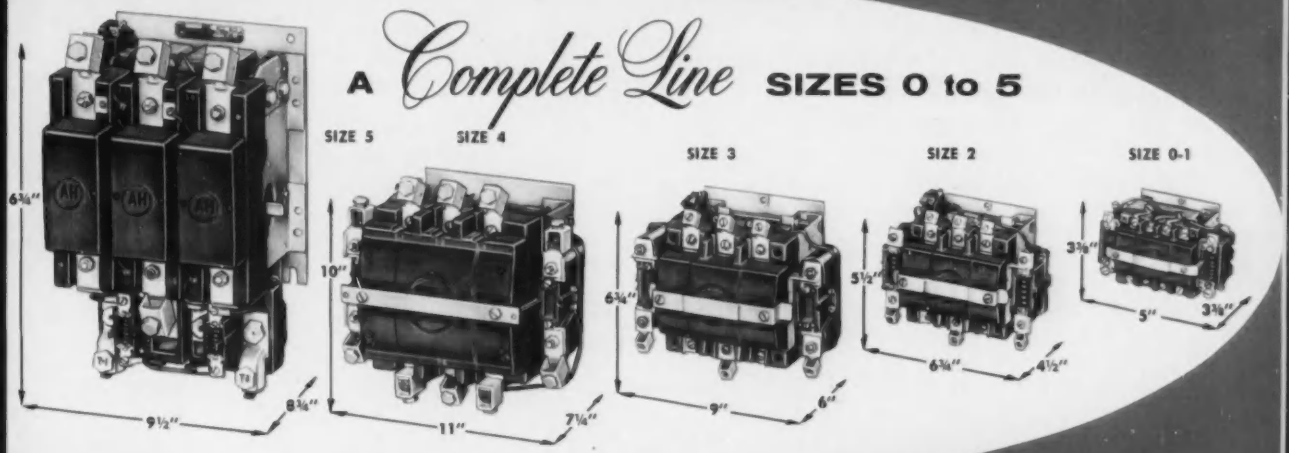
and HALF THE SIZE of Conventional Types

ARROW AH HART

MAGNETIC MOTOR CONTROLS



A *Complete Line* SIZES 0 to 5



When SMALL Space is a BIG Design Problem! . . .

Complex, modern machines call for multiple motor controls; fitting this control equipment into a reasonable area and providing ready accessibility is often a serious design problem. You can solve it easily by specifying Arrow-Hart Type "RA" Motor Controls. Radically smaller and lighter than conventional types, these starters and contactors offer the additional benefits of matchless performance, far greater dependability and much longer life.

With these ALL NEW Features in Sizes 0 and 1 . . .

- **NEW CONTACT DESIGN** . . . and a special alloy for longer life, greater resistance to welding. New metal contact carrier post.
- **RESINOX HOOD AND BASE** . . . for maximum tensile strength and added dielectric strength.
- **NEW AUXILIARY SWITCH** . . . improved, sturdy mechanism; front mounting for easier installation and removal.
- **NEW, SIMPLIFIED "RA" MECHANISM** . . . same compactness plus more efficient operation in industrial atmospheres.

LEADING DESIGN ENGINEERS DEPEND ON ARROW-HART CONTROLS TO SAVE SPACE, INSURE PEAK PERFORMANCE . . . TURN THE PAGE FOR OUTSTANDING EXAMPLES.

ARROW AH HART

THE ARROW-HART & HEGEMAN ELECTRIC CO., Hartford 6, Connecticut

The Leaders look to ARROW AH HART *Advance Design*

MOTOR CONTROLS

. . . FOR SPACE-SAVING COMPACTNESS

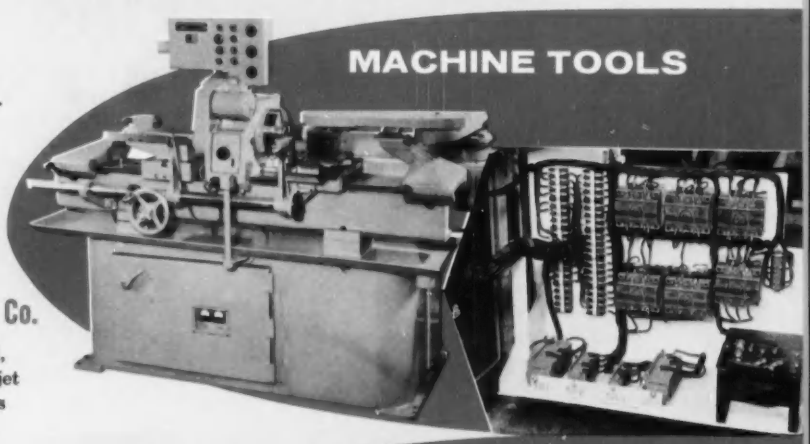
. . . FOR PERFORMANCE-BUILDING DEPENDABILITY

MODEL 102 AIRFOIL MILLING MACHINE

MANUFACTURED BY

The New England Machine & Tool Co.

This ingenious machine mills the original, 3-dimensional masters from which turbo jet blades are manufactured . . . does in hours a job once requiring weeks of hand work. Complexity of the operating and control mechanisms placed a high premium on space, but the 5 smaller, lighter A-H Magnetic Controls were easily mounted on an unusually compact door-back panel that swings out for instant accessibility.

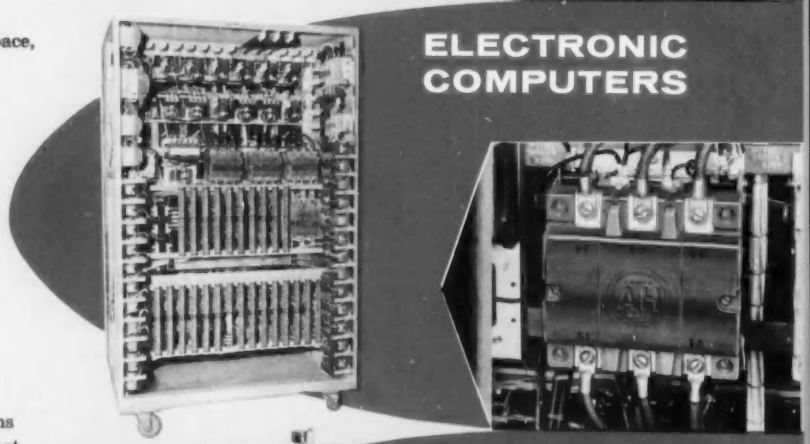


TYPE 704 ELECTRONIC DATA PROCESSING MACHINE

MANUFACTURED BY

International Business Machines CORPORATION

These electronic machines are designed primarily for the use of engineers and research scientists. They are capable of performing more than 4000 multiplications or divisions per second. The 10 Arrow-Hart Contactors included in the very complicated power distribution unit were a natural choice to save valuable space. Other A-H Controls are also utilized in other parts of the machine.



HEV-E-OIL BURNER

MANUFACTURED BY

Cleaver-Brooks Company

Simple, compact and efficient, this modern unit uses low cost, high heat heavy oils to provide economical heat for commercial and industrial buildings. Arrow-Hart Control – an "RA" Starter and a Miniature Relay – occupies little space in the small panel, leaves ample space for easy wiring.

ARROW AH HART

THE ARROW-HART & HEGEMAN ELECTRIC COMPANY
103 Hawthorn Street, Hartford 6, Connecticut
MOTOR CONTROL DIVISION

Please send my copy of the A-H Motor Control Application folder. PE

name _____

position _____

company _____

co. address _____

city _____ zone _____ state _____

ARROW-HART

MOTOR CONTROL DIVISION

THE ARROW-HART & HEGEMAN ELECTRIC COMPANY

103 HAWTHORN STREET, HARTFORD 6, CONNECTICUT

Offices, Sales Engineers and Warehouses in Principal Cities

Quality MOTOR CONTROLS • WIRING DEVICES
ENCLOSED SWITCHES • APPLIANCE SWITCHES

MAIL COUPON TODAY FOR COMPLETE INFORMATION

ifications. Made of high pressure laminated plastic. Formica Co., Cincinnati 32, Ohio.
Circle 148, inside back cover

Multiple V-Belt Drive–Bulletin, 36 pp, covers the evolution of standards in engineering V-belts, tells how to engineer one, provides tables and data, and describes modifications in such drives. Allis-Chalmers Mfg. Co., 1002 S. 70 St., Milwaukee, Wis.
Circle 149, inside back cover

Hydraulic Cylinders–Catalog, 41 pp, describes line of cylinders, 1½ through 12 in. bore, including all mounting data. Hydro-Line Mfg. Co., Rockford, Ill.
Circle 150, inside back cover

Bushings–Slide rule type selector gives dimensions and other data on liner type bushings. Also has decimal equivalents chart. Universal Engineering Co., Frankenmuth, Mich.
Circle 151, inside back cover

Plastic Pipe–Bulletin 80-3, 8 pp, gives information on unplasticized rigid PVC, providing engineering data, and listing over 200 chemicals pipe will convey without being attacked. Joseph T. Ryerson & Son, Inc., P. O. Box 8000-A, Chicago 80, Ill.
Circle 152, inside back cover

Constant-Torque Spring Motors–Bulletin 310 Mb, 25 pp, discusses general principles, physical and operational characteristics, typical applications and application limitations of this mechanical motor. Design procedure and formulas are explained. Hunter Spring Co., Lansdale, Pa.
Circle 153, inside back cover

Air Control Valves–Bulletin, 4 pp, describes 17 different lines of air-control valves and accessories. Airmatic Valve, Inc., 7317 Associate Ave., Cleveland 9, Ohio.
Circle 154, inside back cover

Plate Magnets–Catalog 1205-D, 8 pp, contains engineering data and specifications for 35 standard sizes. Dings Magnetic Separator Co., 4740 W. Electric Ave., Milwaukee 46, Wis.
Circle 155, inside back cover

Ratchet Drive Lubricator–Bulletin, 2 pp, contains a cut-away diagram illus-
(Continued on page 378)

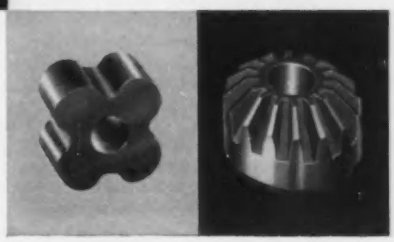
a new expanded field of

BEARING DESIGN and APPLICATION

The inauguration of Bunting's new facility for engineering and manufacturing bearings and parts of Sintered Powdered Metals opens a wide new area of opportunity to all mechanical industry.

Sintered Powdered Metal Bearings and parts offer real economies in design. Bunting Engineering and manufacturing skill and traditional technical responsibility assure your most advantageous use of this material.

A competent group of Bunting Sales Engineers in the field and a soundly established Product Engineering Department put at your command, comprehensive data and facts based on wide experience in the designing and use of Cast Bronze and Sintered Powdered Metal Bearings and parts.



Write to our Product Engineering Department in Toledo, or consult our nearest Sales Engineer.

Bunting®

BUSHINGS, BEARINGS, BARS AND SPECIAL PARTS OF CAST BRONZE AND POWDERED METAL

The Bunting Brass and Bronze Company • Toledo 1, Ohio • Branches in Principal Cities

Dempster-Dumpster—a truck-mounted fork lift designed to handle trash and other bulk materials, shown in dumping position. INSET: "Dacron" is the reinforcement in the V-belts on the 13-inch, 2-groove drive—increasing delivered horsepower, efficiency of hydraulic pump.

How the Dempster-Dumpster's V-belt drive efficiency was increased by premium V-belts reinforced with DACRON

REG. U.S. PAT. OFF.

The lifting and steering power of the Dempster-Dumpster generates from a single hydraulic pump driven by V-belts. To insure dependable, slip-free operation and positive starting at this important spot, Dempster Brothers, Inc., switched to premium V-belts reinforced with Du Pont "Dacron"* polyester fiber. During the six years since the change, the belts have been proving their superiority on hundreds of Dempster-Dumpsters in use throughout the country.

Slippage and stretching have been sharply reduced by the 40% greater strength of belts made with Du Pont "Dacron". Two premium V-belts now do the work formerly handled by three standard belts. The belts remain stable . . . deliver more horsepower from the pump. And the ability of these belts to withstand greater shock loading assures fewer replacements, more efficient, trouble-free operation.

In designing *your* next drive, investigate the advantages of premium V-belts made with "Dacron". They combine the unique properties of the "Dacron" yarn made by Du Pont and the highest skills of the leading V-belt manufacturers. For a list of manufacturers using "Dacron" in premium V-belts, write to E. I. du Pont de Nemours & Co. (Inc.), Textile Fibers Dept., Wilmington 98, Delaware.

**"Dacron" is Du Pont's registered trademark for its polyester fiber.*

6 REASONS FOR USING PREMIUM V-BELTS REINFORCED WITH "DACRON"

- Transmit up to 40% more horsepower.
- Withstand greater shock loading.
- Longer flex life.
- Cut downtime.
- Low stretch.
- Require less maintenance.

"Dacron" in V-Belts DU PONT

REG. U. S. PAT. OFF.

REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

BIGGER THAN YOU THINK

Skinner solenoid valves are compact, tiny and lightweight.

But don't be misled — they'll easily outperform other valves that are much larger and heavier. Built to withstand high voltages and temperature extremes, Skinner valves provide leakproof, trouble-free operation through millions of cycles.

And being small, they are easily adaptable to your most compact equipment design. Call in a Skinner engineer on all your valve problems *first*. He can draw from over 100,000 variations . . . all of them *big in capacity, power and performance.*

Write for the new Skinner Solenoid Valve Catalog. On your letterhead, please.

SKINNER SOLENOID VALVES

SKINNER ELECTRIC VALVE DIVISION · SKINNER CHUCK COMPANY

THE CREST OF QUALITY

SKINNER ELECTRIC VALVES ®

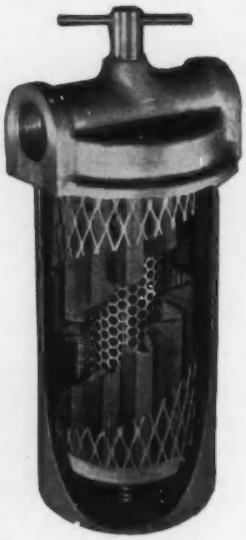
114 Edgewood Avenue
New Britain, Conn.

WORLD-WIDE REPRESENTATION

For Dependable Protection On Hydraulic Equipment

MARVEL SYNCLINAL FILTERS

Over 650 Original Equipment Manufacturers Install Marvel Synclinal Filters as Standard Equipment.



SUMP TYPE (cutaway)

LINE TYPE (cutaway)

Hydraulic Oils MUST BE CLEAN to Protect Equipment— Increase Production— Reduce Maintenance

PRODUCTION ENGINEERS and MAINTENANCE MEN, whose job it is to keep production machinery operating at peak efficiency, are specifying Marvel Synclinal Filters on new equipment and standardizing with Marvels throughout their plants.

It's The ACTIVE Filtering Area That Counts!

The Synclinal design of Marvel Filters provides that all-important balance between maximum ACTIVE filtering area and sufficient storage capacity for filtered out particles. Thus, longer periods of productive operation are attained before filter cleaning is necessary. Marvel Synclinal Filters are easy to clean because both the sump and line type may be disassembled, thoroughly cleaned and reassembled in a matter of minutes. Line type operates in any position and may be serviced without disturbing pipe connections.

A SIZE FOR EVERY NEED

Available for sump or line installation in capacities from 5 to 100 G.P.M. Greater capacities may be attained by multiple installation (as described in catalog). Choice of monel mesh sizes range from coarse 30 to fine 200.

IMMEDIATE DELIVERY!

As in the past, Marvel continues to offer IMMEDIATE DELIVERY.

FILTERS FOR FIRE-RESISTANT HYDRAULIC FLUIDS

Marvel's most recent development is a filter for the efficient filtration of all types of Fire-resistant hydraulic fluids.

WATER FILTERS

Both sump and line type filters have been adapted for use in all water filtering applications. No changes have been made in the basic, balanced synclinal design.

Catalogs containing complete data available on request

MARVEL ENGINEERING CO.
7227 N. HAMLIN AVE., CHICAGO 45, ILL.
PHONE: Juniper 8-6023

Without obligation, please send me complete data on Marvel Synclinal Filters, as follows:—

- ☐ Catalog #107—For Hydraulic Oils, Coolants and Lubricants
- ☐ Catalog #301—For WATER
- ☐ Catalog #200—For Fire-resistant hydraulic fluids

Name .....
Title .....
Company .....
Address .....
City .....
State .....

PE-4

trating the lubricator's operation. Accompanying the diagram is a table listing ratchet arm working angles. Bijur Lubricating Corp., 151 W. Passaic, Rochelle Park, N. J.

Circle 156, inside back cover

Letterhead Requests Only

Manufacturers who published following literature ask that requests for copies be made on company letterheads.

Electrical Detector Systems—Booklet, 8 pp, describes equipment checking system consisting of electrical circuits wired to schematic diagram control panels. W. F. & John Barnes Co., 301 S. Water St., Rockford, Ill.

Circle 165, inside back cover

Miniaturization—Booklet, 20 pp. Illustrated with charts and photographs, importance of precise laboratory information on physical strength and probable loads as a prerequisite to using the smallest possible part is shown. Simplified charts evaluate S-N (stress-strain) curves in miniaturization design; S-N curves show fatigue limits in bolts of similar size made of steel and of titanium. Standard Pressed Steel Co., Box 545, Jenkintown, Pa.

Independent Laboratories—1956 Directory, 98 pp. In addition to information sheets for 67 member laboratories, which provide details of facilities and services, this edition of the directory includes an index of services and facilities. The index lists over 400 categories of services from abrasion testing to wool testing, from adhesives to waxes, from air pollution to vitamin research. Each category lists through code numbers the member laboratories specializing in each field. American Council of Independent Laboratories, Inc., 4302 East-West Highway, Washington 14, D. C.

Extrusions—Booklet, 16 pp, covers extrusions from stainless steels, heat-resistant alloys, titanium, alloy steels, carbon steels and specialty bronzes. H. M. Harper Co., 8200 Lehigh Ave., Morton Grove, Ill.

Mechanical Spring Design—Handbook, 79 pp, contains charts and formulas, tables and descriptive data. Associated Spring Corp., Bristol, Conn.

5 REASONS FOR BUYING
BELLOWS FROM FULTON SYLPHON

Seamless Metal Bellows

One-piece design—no soldered joints—assures longer life.

All Types, Sizes and Metals

Designed to your individual requirements and specifications.

On-Call Engineering Service

Fulton Sylphon Bellows Engineers provide quick, reliable advice on application problems.

Assemblies and Complete Devices

Bellows and related parts fully assembled with big savings in time, trouble, and money.

On-Time Delivery • No Delays

Modern facilities, strict quality control, and follow-through eliminate customer worries.

FULTON SYLPHON

BELLOWS HEADQUARTERS, U. S. A.

Robertshaw-Fulton CONTROLS COMPANY

FULTON SYLPHON DIVISION

Knoxville 1, Tennessee

☐ Please have Bellows Engineer call.

☐ Send me Bellows Engineering Catalog GP-1400.

Name_____

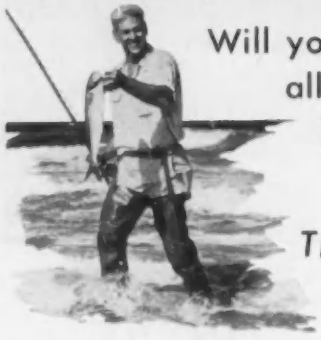
Company_____

Address_____

City_____ State_____

ENGINEERS...
LOOK TEN YEARS AHEAD!

A Douglas engineer lives here



Will your income and location allow you to live in a home like this...spend your leisure time like this?

They can...if you start your career now at Douglas!

Take that ten year ahead look. There's a fine career opportunity in the engineering field you like best waiting for you at Douglas.

And what about the Douglas Aircraft Company? It's the biggest, most successful, most stable unit in one of the fastest growing industries in the world. It has giant military contracts involving some of the most exciting projects ever conceived...yet its commercial business is greater than that of any other aviation company.

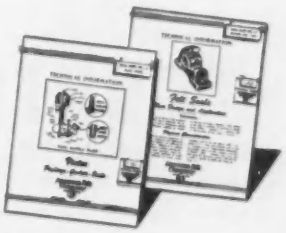
The Douglas Company's size and variety mean that you'll be in the work you like best—side by side with the men who have engineered the finest aircraft and missiles on the American scene today. And you'll have every prospect that ten years from now you'll be where you want to be career-wise, money-wise and location-wise.

For further information about opportunities with Douglas at Santa Monica, El Segundo and Long Beach, California and Tulsa, Oklahoma, write today to:

DOUGLAS AIRCRAFT COMPANY, INC.
C. C. LaVene, 3000 Ocean Park Blvd.
Santa Monica, California

DOUGLAS **First in Aviation**

The seals shown here are a combination of felt for shaft lubrication, plus spring-loaded leather or rubber for exclusion of water, fumes, dust. Such seals are made by a number of companies, in standard and special diameters. List of firms on request. Felt seals can also be made impervious by metal enclosures, or by the use of felt with one or more laminations of synthetic rubber. Just remember that felt is so versatile that it can either lubricate or seal, or both at the same time. On request we will collaborate on designs and specifications. Write for Data Sheet No. 11, "Felt Seals, Their Design and Application," and for No. 14, "Vistex, Packings, Gaskets, Seals."



American Felt Company
TRADE MARK ®

GENERAL OFFICES: 78 GLENVILLE ROAD, GLENVILLE, CONN.

SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Greenville, S. C., Dallas, San Francisco, Los Angeles, San Diego, Portland, Seattle, Montreal.—PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I.—ENGINERING AND RESEARCH LABORATORIES: Glenville, Conn.

FREE! Write for Data Sheets Nos. 11 and 14.

UNIFORM QUALITY
DIVERSE
APPLICATIONS

Each part of every Curtis Universal Joint is made of specially selected steel, individually heat-treated for a specific purpose. This care in manufacture is reflected in our catalog torque and load ratings — which are substantiated by constant testing of production joints.

That's why Curtis Joints are the most dependable, durable and trouble-free available—the standard of the industry.

CURTIS UNIVERSAL JOINTS

- 14 sizes always in stock — bored or unbored hubs 3/8" to 4" O.D.
- Fewer parts, simpler construction
- Complete equipment for government tests

PLUS — facilities and engineering skill to handle special specification jobs at any time.

Not sold through distributors. Write direct for free engineering data and price list.

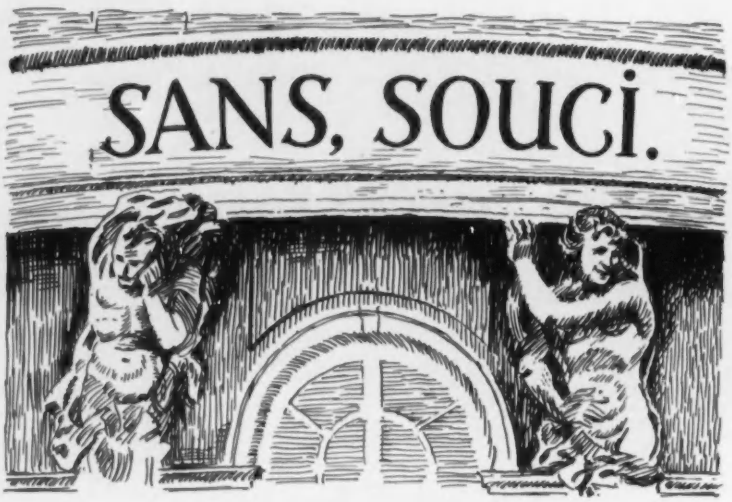
TRADE MARK **CURTIS**

UNIVERSAL JOINT CO., INC.

11 BIRNIE AVENUE, SPRINGFIELD, MASS.

As near to you as your telephone

A MANUFACTURER OF
UNIVERSAL JOINTS SINCE 1919



Ad Libbing by the Editor

We learn only through "blood, sweat and tears." It seems that in all the centuries of recorded history there never has been an instance in which there has been a great step forward other than one stimulated or instigated by disaster, misery, injustice, treachery or ruthless conquest. Likewise, individual ambition, energy and success seem to stem, in most instances at least, from hardship or misfortune suffered by the individual.

"Easy pickings" has never made heroes or great leaders to whom the world or any part of it, is indebted. There are some who dispute the truth of Oliver Goldsmith's famous lines: "Ill fares the land to hastening ills a prey, where wealth accumulates and men decay." They contend that the accumulation of wealth is not necessarily accompanied by decay. That is true. But if both happen, "Ill fares the land."

On a hot summer's day, covered with sweat and with the stench of the vapors from the heat-treating vats filling his nostrils, Bill Muller got thoroughly exasperated. It seemed that no matter what he did the "go" gages did not "go" and "no-go" gages went. Finally it was more than he could take, so with an, "Oh the hell with it," he put on his hat and walked over to the "big" boss.

"Chief," he said, "I'm through."

Fred Larkin smiled and gave a sort of half chuckle and said, "Bill, I'm surprised. If I had thought that was an easy job I would have had Fred Bowers tackle it. But I figured it needed a man with your kind of ability, and guts besides, to put it across.

"Now you're telling me that the tolerances are all wrong, that it is impractical to hold the dimensions, that only a bunch of day dreaming military brass could think up a cockeyed design like this one. But let me remind you that Bethlehem Steel, Ingersoll-Rand and a few other companies are also making these shells and all to the same tolerances.

"And, Bill, let me also add that if any Tom, Dick or Harry could machine those shells your job would be worth only about fifty cents an hour. You are worth what you are getting only because in the past you have licked dozens of problems like the one that now seems to floor you. And don't forget, that once you let a thing like this floor you, you are sunk. But if you lick it you are then ready to lick a bigger problem."

Bill stayed. And the problems got bigger. He kept on licking them as they came along. His pay went up. He became prosperous. But he never stopped licking problems.

Individually and collectively, man's tendency is to quit "when the going is good." That has been the history of nation after nation. In most instances it was the penalty they paid for conquest. Rome was mighty and powerful all through the years in which her armies were conquering the world. But the moment Rome quit struggling and started to live off the labors of slaves, disintegration set in. The country decayed not because it

(Continued on page 387)

How to reach the equivalent of 4 suppliers in one call for—

1. precision metal stampings and wire forms
2. custom-molded plastic parts in thermoplastic and thermosetting materials
3. custom plated, clad, or alloyed, cold-drawn wire in sizes from .250 to .002
4. electronic components designed to meet the latest needs of equipment designers

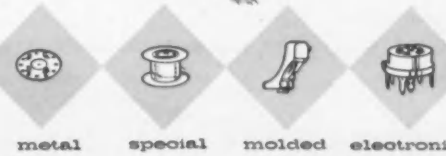
Most products include parts which call for one or more of the services above. Some products call for all of them. And all of these facilities are available to you in Sylvania's unique four-way service to designers. One call brings them to your door promptly.

Sylvania's Parts Division Representative serves as your complete parts and wire consultant. He is experienced in applying the benefits of completely modern and automatic equipment to your particular problems.

And he knows design problems straight through from drawings to deliveries. He's your liaison to Sylvania's complete staff of designers, engineers, production specialists, and tool and die makers.

Why not make that one call that will bring you the equivalent of four suppliers? Call your nearest Sylvania Parts Representative. He's listed in Sweets Catalog Service. Write for the "portfolio of 4-way service to designers."

PARTS DIVISION



metal stamping | special wire | molded plastic | electronic parts

Sylvania invites you to call on the Parts Division for consultation at any time without obligation

SYLVANIA®

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd.
University Tower Bldg., Montreal

LIGHTING • RADIO • TELEVISION • ELECTRONICS • ATOMIC ENERGY

The DESIGN ENGINEERING SHOW

Convention Hall
PHILADELPHIA
May 14-17, 1956

Make it . . .

lighter . . . stronger . . .
faster . . . less expensive . . .
easier to produce . . .
more attractive . . . quieter . . .
easier to operate . . .
more automatic . . .

Find . . .

the materials, components, fasteners, finishes, parts, shapes and forms you need to solve your design problems.

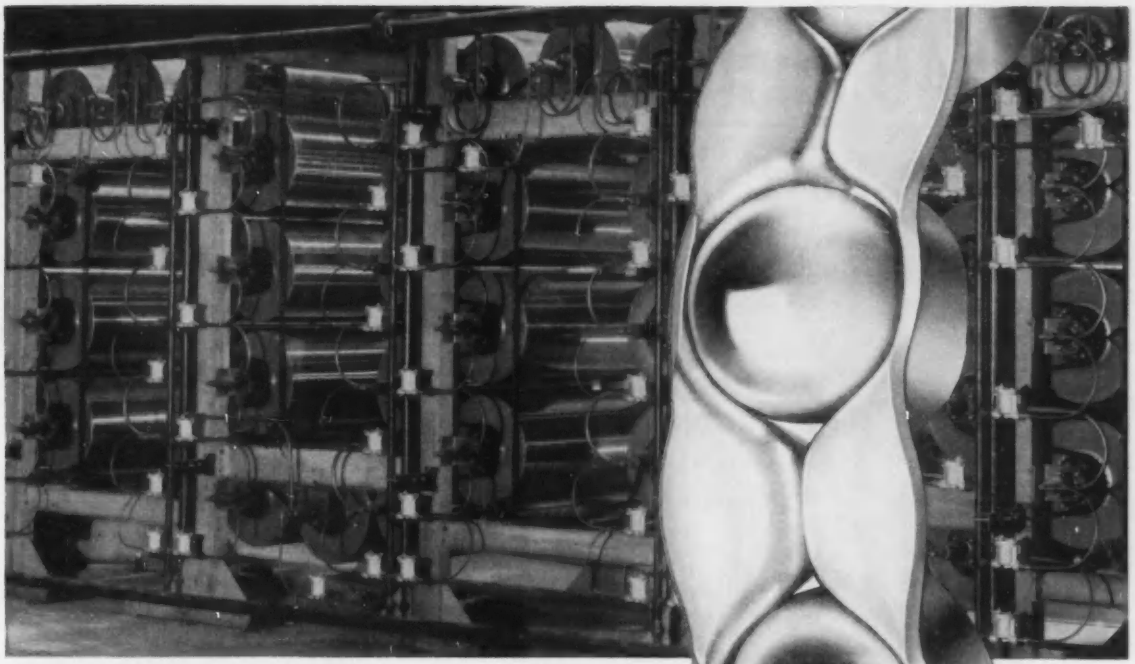
Now you can see *in action* and compare hundreds of design components —in person—in one place, under one roof. 200 outstanding progressive manufacturers will present a huge array of the things you can incorporate into the design of better products for your company. A visit to the Design Engineering Show is an *idea trip*. Exhibitors will show countless new applications of their products to suggest to you scores of ingenious solutions to your design problems. There'll be graphic demonstrations of physical, chemical and electrical properties; opportunities to discuss your needs with top technical experts; product samples available for you to test for yourself.

Plan now to attend! Write for free registration cards and information about the concurrent conference to

DESIGN ENGINEERING SHOW
Clapp & Poliak, Inc.
341 Madison Avenue, New York 17, New York
MUrray Hill 4-3432

THE DESIGN ENGINEERING CONFERENCE

Sponsored by Machine Design Division of the American Society of Mechanical Engineers
A three-day program with top speakers covering: cost reduction in product design; problems of design engineer procurement; selection of engineering materials; methods of miniaturization; inventions and patents.
Write for complete Conference program and registration forms.



SEALMASTER'S (PATENTED) BALL RETAINER

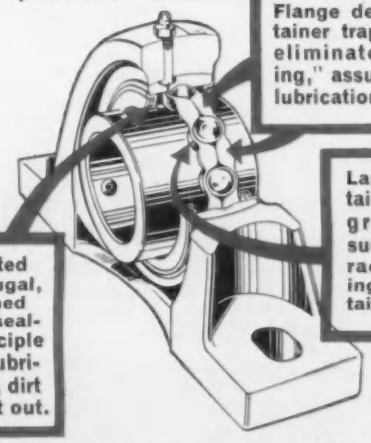
- **Stops "Churning" of grease!**
- **Assures equal load distribution!**
- **Minimizes Ball and Retainer wear!**

"Churning," caused by failure of a retainer to keep grease confined within the ball path of a bearing is another problem that has been eliminated by a SEALMASTER patented engineering feature!

SEALMASTER's patented Ball Retainer features a special flange construction which projects from the outer dimensions of the retainer. This flanged lip confines grease—minimizing centrifugal action. The retainer floats on the ground inner surface of the outer race, eliminating excessive wear of balls and retainer. Accurate spacing of balls assures effective distribution of radial and thrust loads.

This is just one of SEALMASTER's exclusive combination of features you will want on the products you build or buy.

Only SEALMASTER offers you these patented features!



Flange design of retainer traps grease—eliminates "churning," assuring proper lubrication of balls.

Land ridden retainer floats on ground inner surface of outer race—minimizing ball and retainer wear.

Patented centrifugal, felt-lined flinger sealing principle keeps lubricant in, dirt and dust out.

WRITE FOR FULL INFORMATION

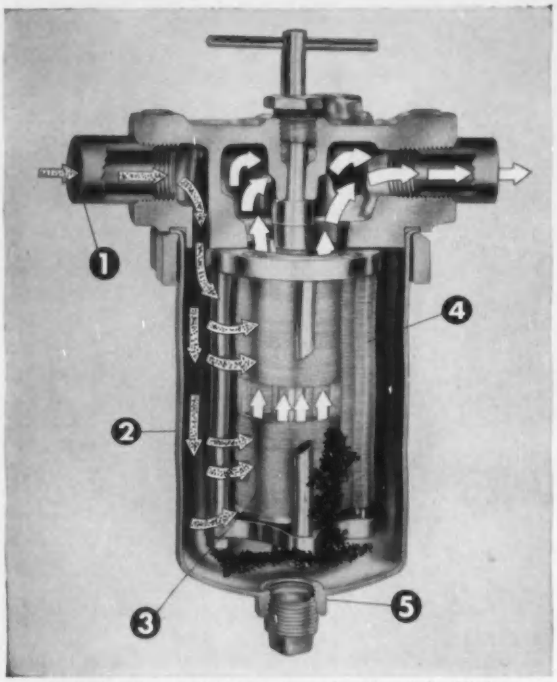
SEALMASTER

BALL BEARING UNITS

SEALMASTER BEARINGS A DIVISION OF STEPHENS-ADAMSON MFG. CO., 9 RIDGEWAY AVENUE, AURORA, ILLINOIS

NOW! 40-micron, self-cleaning filter

It's the new Cuno SUPER Auto-Klean



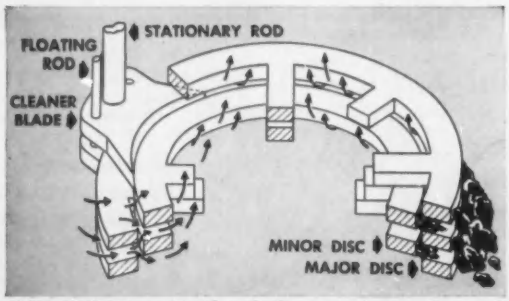
HOW IT WORKS. Dirty oil enters inlet (1) at left, fills housing (2) and flows through metal edge-type filter (3). Clean oil rises through center of filter, leaves at right. Dirt combed out by cleaner blades (4) is removed through drain (5).

Cuno's new SUPER Auto-Klean is the first practical, compact micronic filter for lubricating oil, hydraulic fluid, coolant, fuel, and other industrial fluids.

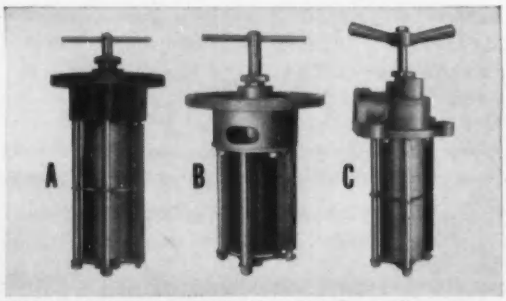
Many times smaller than other micronic filters of equal capacity, Cuno's new SUPER Auto-Klean filter now makes possible economical, micronic filtration at high flow rates and eliminates the need for replacement cartridges in most cases. Here's what it offers:

1. **Full-flow** 40-micron filtration with a self-cleaning filter. Positive protection against particles larger than 40 microns (actually 0.0015 in.). All-metal filter can't rupture or channel.
2. **Easy cleaning.** Just turn the handle—by hand or continuously with motor drive. No interruptions for cleaning.
3. **No cartridge changes.** Ends operating costs if you've been using cartridge filters.
4. **Low pressure drop, no pressure drop build-up.** An 8" by 2¼" SUPER Auto-Klean filters 30 gpm of 200 SSU oil with only 3 psi pressure drop—up to 75% more with slightly higher pressure.
5. **High capacity in a small package.** Many times smaller than replaceable-cartridge type filters of equal capacity, it saves with lower initial costs, lower installation costs.
6. **Easy to build into new equipment.** Available for line-type housings *(left)* or incorporation in sump or reservoir *(below.)* Works in any position.
7. **Easy to install in old equipment.** Fits existing Auto-Klean housings. You can easily replace most 2¼" diameter elements with SUPER Auto-Klean for finer filtration.

Write today for complete technical data on the new SUPER Auto-Klean for your new or existing equipment. Ask for Catalog No. SAK-057. Cuno Engineering Corporation, 20-4 South Vine Street, Meriden, Connecticut. 5.9



FILTER ELEMENT consists of stacked major and minor discs and cleaner blade bearing against minor discs. Small arrows show flow. Short restrictions between minor and major discs stop 40-micron particles but allow high flow rate.



FILTERS FOR INTERNAL PIPING *(A and B above)* allow streamlined design plus the best infiltration. Flange mounting with external outlet *(C above)* and line-type *(large cutaway above left)* are just a few of many other possibilities.

CUNO

ENGINEERED FILTRATION

Removes More Sizes of Solids From More Kinds of Fluids

AUTO-KLEAN (edge-type) • MICRO-KLEAN (fibre cartridge) • FLO-KLEAN (wire-wound) • PORO-KLEAN (porous metal)

was wealthy but because the people became lazy and unambitious.

Great moments in history have always been born of disaster, cruelty, suffering or human frailties. The Titanic disaster brought forth new rules, regulations and navigation precautions that have undoubtedly saved many times the number of lives lost in that terrible tragedy. The shots that killed the strikers at Homestead Steel did more for the welfare of steel workers than did the total of all the strikes before or since. The horrible Triangle Shirt Waist factory fire that killed hundreds resulted in the finest labor union, as measured by benefits to both management and workers.

The suffering and hardships of the 1930 depression brought forth many reforms in the fields of banking and industry, impelled the passage of many social measures such as unemployment compensation, social security and federal insurance of bank savings.

In the midst of the slaughter of the Crimean War, Florence Nightingale founded the Red Cross. Care Packages were brought about by the starvation in war torn Europe. Such examples are endless.

One man remarked, "Must we have such suffering to bring people to their senses?" The answer is, Yes! There can be no cure for suffering that does not exist. Nor can we eradicate suffering that does not exist. Nor is man willing to sacrifice unless he feels that somebody will get good out of it. Which all points to the fact that humans will do nothing to prevent what might happen until after it has happened. We act only on what is or has been.

The final objective of all design engineering is to create machinery that will lighten the burdens of man and develop products through the use of which he can live in greater comfort. Likewise, each of the other professions contributes it share toward making this earth a better place to live.

But we must never forget that many of our hardships, misfortunes and tragedies are really blessings in disguise. Of course we do not like them. And if it is at all possible we avoid them. But whenever such things happen every effort should be made to find the answer to the question, "What can we do about it?"—G.F.N.

CLUTCHES FOR POWER CONTROLS DESIGNS

THE NEW HILLIARD-TWIFLEX

Centrifugal Coupling

1 AUTOMATIC smooth starting with protection against overload shock.

2 FLEXIBLE in all directions without any loose joints.

3 ADJUSTABLE to exactly suit the operating conditions.

4 SIMPLE CONSTRUCTION and easy assembly even in blind installations.

Hilliard-Twiflex Centrifugal Couplings provide automatic shockless power transmission and trouble-free operation even under relatively great misalignment without any lubrication whatsoever.

They are being used very successfully in the drive of compressors—agricultural sprayers—mixers—conveyors—generators—fans and blowers—pumps—hammer mills—crushers—winches and hoists—refrigeration equipment—textile machinery—and wherever smooth, efficient operation is needed.

Tests in a variety of installations for over five years prove the Twiflex is the practical solution to many drive problems.

WRITE TODAY FOR BULLETIN CE-3 WITH COMPLETE INFORMATION.

★

• OTHER HILLIARD CLUTCHES •

SINGLE REVOLUTION CLUTCHES for automatic accurate control—electrical or mechanical—of intermittent motion, indexing, cycling and cut-off. Ask for Bulletin 239.

OVER-RUNNING CLUTCHES for automatic instantaneous engagement and release on two speed drives, dual drives and ratchet or backstop action. Ask for Bulletin 231.

SLIP CLUTCHES for overload protection, or constant torque and to provide constant tension and permit speed variation on rewind stands. Ask for Bulletin 300.

★ CONSIDER AUTOMATION-INVESTIGATE THESE PRODUCTS

THE HILLIARD Corporation

MANUFACTURING CLUTCHES FOR OVER 50 YEARS

101 W. Fourth St. Elmira, New York

IN CANADA: UPTON • BRADEEN • JAMES, LTD.

RICHARDSON

helps improve molded auto parts

Each of the molded parts pictured here had specifications which called for special materials often with unusual properties. All called for creative design approaches, both by customer and Richardson.

Richardson engineers, specialists in both molded and laminated plastics, will welcome the opportunity to help you. Write or phone for additional information.

THE RICHARDSON COMPANY
FOUNDED 1858
2793 Lake St., Melrose Park, Ill. (Chicago District)

MELROSE PARK, Ill.

INDIANAPOLIS, IND.

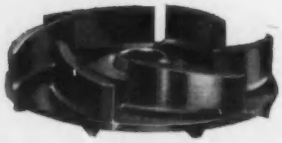
NEWNAN, GA.

OGDEN, UTAH

SALES OFFICES IN PRINCIPAL CITIES

NEW BRUNSWICK N. J.

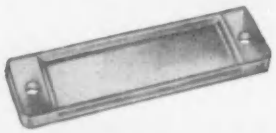
TYLER, TEXAS



. . water pump impeller A special moisture resistant phenolic was specified for this part which must withstand the extremes of both high heat and intense cold, as well as strong torque action plus corrosion and cavitation resulting from the circulation of water in the car's cooling system.

. . timing gear The molded blank of this gear had to have high flexural characteristics . . also a good bond in the laminate section for ease in cutting gear teeth, and to insure necessary tooth strength. The manufacturer and Richardson developed a new material with high heat resistance. Result: Fine flexural strength in the web section . . more quiet operation . . . easier fabrication . . . easier assembly . . . *tripled gear life!*

. . radio antenna mast base This part had to have good surface appearance, high impact strength, high dielectric strength, and at the same time be weather resistant. A black phenolic material with an attractive high gloss finish was recommended.



. . dashboard light lens Originally this part was designed as a clear lens. Later, when the specifications were changed to call for a translucent lens, the customer suggested that either the mold, or the clear parts, be sandblasted. . either process would have increased costs. Richardson suggested, instead, a special light-transmitting polystyrene. Result: 15% reduction in lens cost.

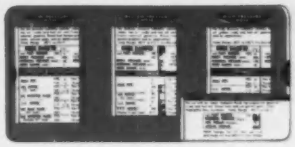
RICHARDSON PLASTICS

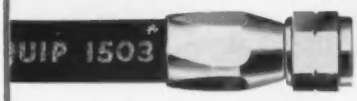
MOLDED AND LAMINATED

Get Complete Fluid Line Information from AEROQUIP CATALOGS

Now you can get the most complete hose line information available in these four informative, compact Aeroquip Catalogs . . . covering aircraft, industrial, marine and farm products. Each catalog offers invaluable aid in specifying, ordering and installing the proper Aeroquip hose lines, fittings, elbows, adapters and self-sealing couplings. Your request brings the catalog you need, at no cost. Write for it!

Free Hoselector! **This compact new Aeroquip "Hoselector" gives quick data on the most popular Aeroquip hose and fittings. Given are fluid applications, temperature and pressure ranges, band radii and fitting types. Helpful to all design engineers . . . it's yours for the asking, just write.**





AEROQUIP SINGLE WIRE BRAID 1503 HOSE for medium pressure hydraulic, water, fuel oil, crude and fuel oil, anti-freeze, gasoline, diesel fuel and air lines. In sizes from ¼" to 3", pressures up to 3000 p.s.i.; temperature range —40°F. to +275°F.

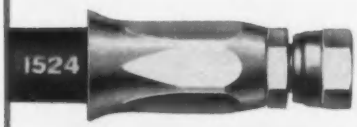
AEROQUIP 1525 HOSE and *SOCKETLESS* fittings for low pressure oil, fuel and air lines on all applications. In sizes from ¼" to ¾"; for pressures up to 250 p.s.i.; temperature range —40°F. to +200°F. *SOCKETLESS* fittings in male pipe, SAE, J.I.C. threads. (Patent applied for.)

AEROQUIP DOUBLE WIRE BRAID 1509 HOSE for high pressure hydraulic, grease, crude and fuel oil, gasoline and air lines. In sizes from ¼" to 2"; pressures up to 3000 p.s.i., depending on size; temperature range —40°F. to +200°F.

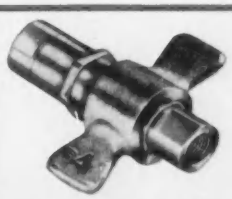
AEROQUIP WIRE BRAID 1533 BUTANE-PROPANE HOSE for LPG engine plumbing or fixed installations where vibration is a problem. Listed by Underwriters' Laboratories. In sizes from ¼" to 2"; for pressures up to 1500 p.s.i., depending on size.

AEROQUIP'S NEW 1546 HIGH PRESSURE HOSE for fire-resistant hydraulic fluids of the Pydraul F-9 and Cellulube type. Ideal for industrial "hot spots". In sizes from ⅛" to 2"; pressures up to 5000 p.s.i., depending on size.

AEROQUIP FREON HOSE for use on automotive and commercial air conditioning units and refrigeration equipment using Freon 12. In sizes from ¼" to 2"; for pressures up to 300 p.s.i.; temperature range —20°F. to +170° F



AEROQUIP 1524 BURST-PROOF STEAM HOSE with ***"little gem"*** fittings for steam cleaning units, dry cleaning and pressing equipment, foundry equipment, plastic molding presses, rubber curing and vulcanizing equipment. Sizes ½" to 1", for pressures up to 200 p.s.i. (388°F.). With or without oil resistant cover.



AEROQUIP SELF-SEALING COUPLINGS allow quick separation and reconnection of fluid lines without loss of fluid or inclusion of air into the system. Replaces two shut-off valves. In sizes from ⅛" to 1½", for pressures up to 2000 p.s.i.; temperature range —40°F. to +250°F.

SOCKETLESS and ***"little gem"*** are Aeroquip trademarks

Engineering assistance available to manufacturers.

Aeroquip

REG. TRADEMARK

AEROQUIP CORPORATION, JACKSON, MICHIGAN

IN CANADA: AEROQUIP (CANADA) LTD., TORONTO 15, ONTARIO

LOCAL REPRESENTATIVES IN PRINCIPAL CITIES IN U.S.A. AND ABROAD • AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U.S.A. AND ABROAD

TWIN CONTACT
Relays

No more "priority"!

Expanded production enables us to offer our Telephone type twin-contact Relays to any industry.

For many years, Stromberg-Carlson production of twin-contact Telephone type relays has been completely absorbed by the independent telephone industry.

Last year, we became a division of General Dynamics Corporation. A five-million-dollar expansion program is under way and one result is already increased relay manufacturing facilities, enabling us to broaden our distribution.

These relays—proven by years of reliable service in the telephone field—are designed to operate under extreme ranges of temperature and humidity. They are made in many types of which these are typical.

Type A is a general-purpose relay especially adapted to the control of switching operations.

Type B is a gang-type relay which can be equipped with three times the number of spring combinations as the "A" type.

Type C. Two relays on the same frame; mounts in same space as the "A" type. It is particularly effective where small space is a factor.

Type D. Miniature general-purpose relay of approximately ⅓ the size of "A".

The catalog in the photograph above gives fuller specifications. We'll gladly send one on request.

S-C STROMBERG-CARLSON

STROMBERG-CARLSON

A DIVISION OF GENERAL DYNAMICS CORPORATION • TELEPHONE INDUSTRIAL DEPT., 119 CARLSON ROAD, ROCHESTER 3, N. Y.

TECHNICAL ABSTRACTS

Residual Voltage in Induction Motors

Abstracted from "Residual Voltage in Induction Motors Influences Load Transfer Time" by R. C. Moore, Motor and Generator Dept., Allis-Chalmers Mfg. Co., Milwaukee, Wis., *Allis-Chalmers Electrical Review*, Third Quarter, 1955.

When an induction motor is disconnected from power source, voltage at motor terminals does not instantly drop to zero, as shown in Fig. 1. Since motor's magnetic flux exists and motor revolves, voltage is induced in stator winding. Voltage magnitude at any given instant after the motor has been disconnected will depend both on decay of flux and decrease in motor speed. The instant after disconnection, this voltage, E_o in Fig. 1, is near line voltage, E_L. Frequency of residual voltage corresponds to motor speed.

If motor is reconnected to another power source before residual voltage has appreciably decreased, undesirable large transient currents and damaging torques can result except in rare cases where phase displacement between motor residual voltage and new supply voltage happen to be suitable. By appropriate relaying, however, it is possible to transfer one motor or group of motors from one supply to another rapidly at instant when voltage-phase conditions are most suitable.

For a given time after disconnection, residual voltage is greater on high speed than on low-speed motors. Higher speed motors therefore present greater hazard when switching from one power source to another before residual voltage has decayed to zero. It is not essential that residual voltage be zero before reconnecting motor to a new supply source, but residual voltage that can be tolerated depends on motor characteristics and operating practices.

The direct current in the rotor and associated rotor flux of an induction motor are analogous to the rotor current and flux of a synchronous generator with d-c field excitation. At full speed, flux induces in stator windings voltage, E_o, which is residual voltage. After disconnection, residual voltage decays according to open-circuit time constant, T_o of Eq (1).

$$T_o = \frac{X_m + X_2}{\omega R_2} \text{ (sec)} \qquad (1)$$

Where: X_m is magnetizing reactance in stator terms
X_2 is motor reactance in stator terms
R_2 is motor resistance in stator terms
ω is 2 times line-voltage frequency

Rms voltage induced in stator winding by decaying rotor flux and current can therefore be expressed as:

$$E_o = E_L \frac{e - t}{T_o} \text{ (rms volts)} \qquad (2)$$

When

(Continued on page 395)

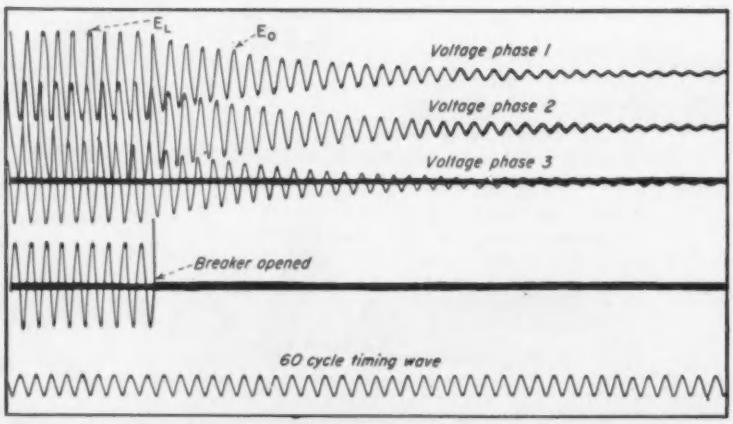
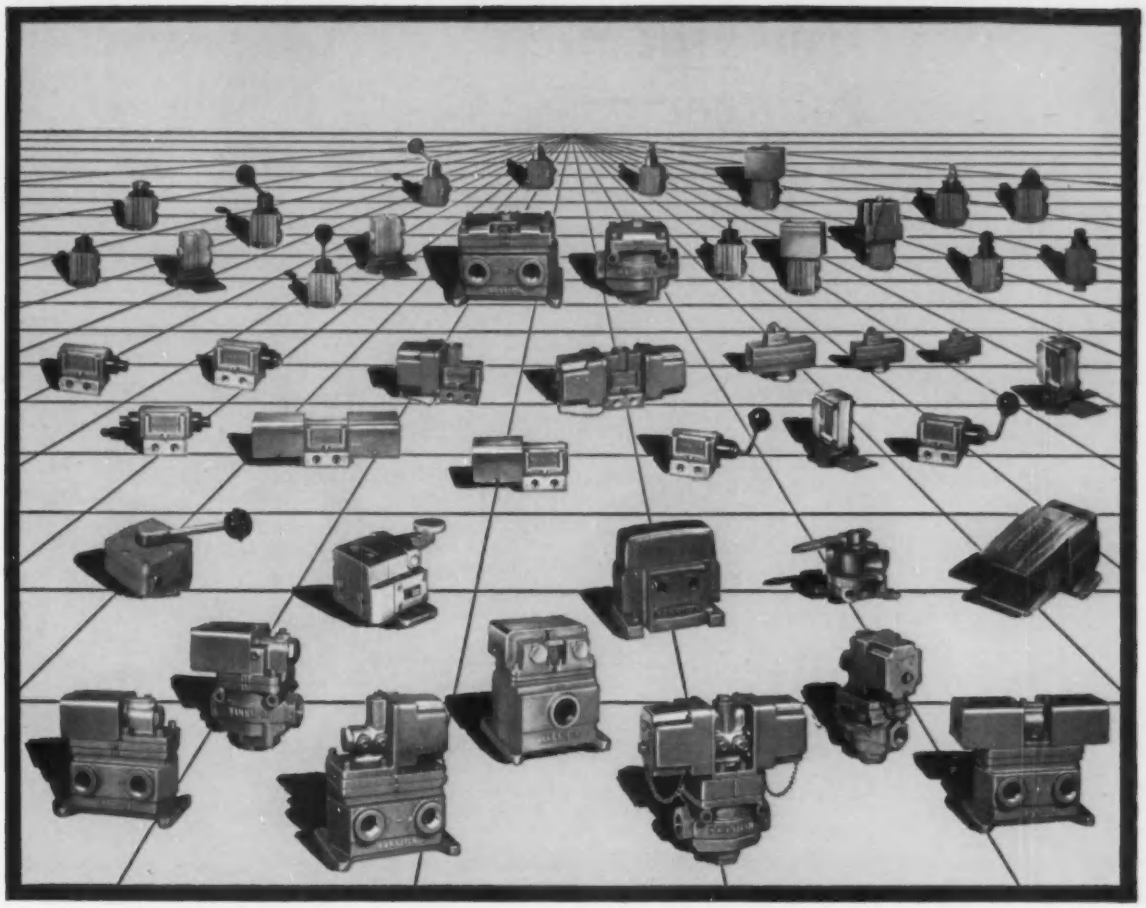


FIG. 1—Decay of residual voltage from the opening of motor breaker; oscillogram for a 440-v, 250-hp, 350-rpm, three-phase, 60-cps motor.

FOR AIR CYLINDER CONTROL... Manual or Electric



Hannifin is your best valve source

What air control valves do you need, or prefer? Hannifin has all types—for your production lines or the machines you manufacture. They include:

P-M Pilot-Master Valves, solenoid controlled by integral pilot heads (including new-type, dust-tight, splashproof heads that completely meet J.I.C. recommendations). ⅜" to 1¼". 2-way, 3-way and 4-way.

P-M Master Valves. ¾" to 1¼". 2-way, 3-way and 4-way, air operated. For remote control from a wide choice of P-M Pilot Valves.

P-M Direct-Operated Valves. For direct control of small air cylinders. 2-way, 3-way and 4-way. ¼" and ⅜".

Disc Valves. Rotary and sliding reciprocating disc types for hand, foot or electric operation. ⅛" to ¾".

Micrometric Speed Control Valves for micrometer-like speed adjustment through control of exhaust flow.

You can simplify your air control problems by standardizing on Hannifin.

Stock Delivery On All Types

HANNIFIN

MAIL THE COUPON FOR PROMPT ACTION

- ☐ Have Field Engineer call at once
- ☐ Have Field Engineer stop by soon
- ☐ For the present, just send complete Hannifin Control Valves Catalog

Hannifin Corporation, 525 S. Wolf Rd., Des Plaines, Illinois

Name.....*Title*.....

Company.....

Address.....

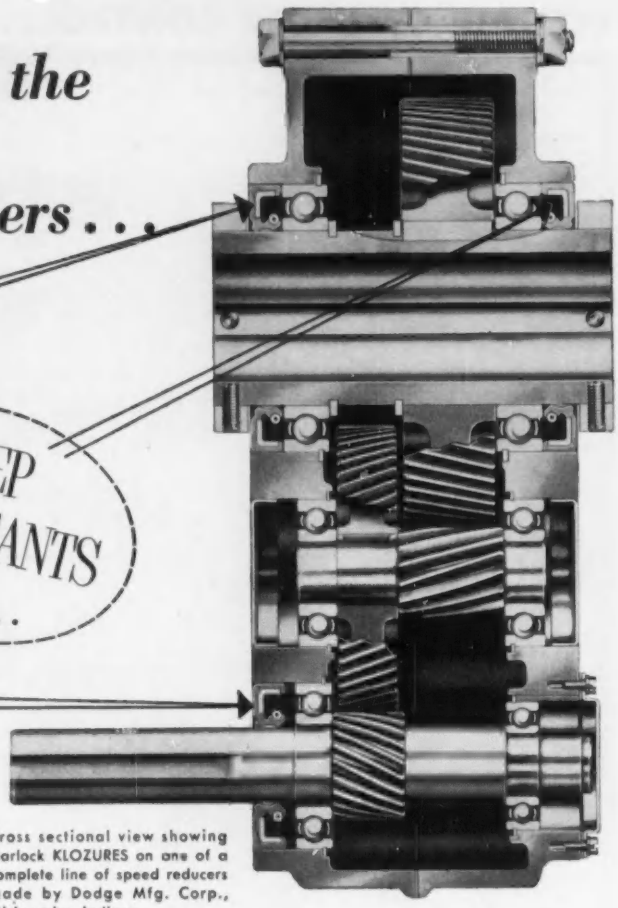
City.....*Zone*.....*State*.....

Over half the speed reducer manufacturers . . .

KEEP DIRT OUT . . .

KEEP LUBRICANTS IN . . .

WITH KLOZURE* Oil Seals



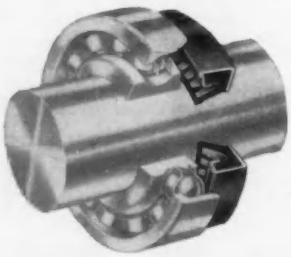
Cross sectional view showing Garlock KLOZURES on one of a complete line of speed reducers made by Dodge Mfg. Corp., Mishawaka, Indiana.

Makers of such fine precision products as The Dodge Torque-Arm Speed Reducer will not compromise when specifying oil seals. They know that the reputation of their entire product may depend on the quality of the oil seals they put in it.

Think about this the next time you have occasion to specify oil seals, and we think you'll choose Garlock KLOZURE Oil Seals—guaranteed to do the job you specify with minimum power loss and heat generation.

KLOZURES are available in a complete range of types and sizes. Therefore, be sure to call in one of Garlock's 125 trained sales engineers right at the start. His experience will save you time and money. Or, write today for Catalog No. 10.

**Registered Trademark*



Model 53 finger spring KLOZURE for normal and high speed service, applied to a shaft to protect the ball bearing.

THE GARLOCK PACKING COMPANY, Palmyra, New York

For Prompt Service, contact one of the 30 sales offices and warehouses throughout the U.S. and Canada.

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints

AL CHROMIUM-MANGANESE *LOW-NICKEL* STAINLESS GRADES

Here is a direct answer to the recurring problem of nickel shortage. For many users of chromium-nickel austenitic stainless steels, the new AISI 200-series of chromium-manganese low-nickel austenitic grades can be a source of immediate relief—and an avenue to the reduction and possible avoidance of nickel shortage problems in the future.

In many cases, you can switch directly from the older Type 301 and 302 grades to the new AL Stainless Type 201 and 202 steels, using the same fabricating processes and securing about the same results. There's nothing new to learn, and no loss in performance in practically all applications. In certain respects, these steels have better properties than the older materials and may be used to actual advantage in some cases.

We also produce low carbon grades of these chrome-manganese steels, arbitrarily designated Types 204 and 204L (similar to the older grades 304 and 304L) . . . as well as a lower-chromium, higher-manganese grade designated Type CM, which contains only 1% nickel. Allegheny Ludlum has pioneered in the development and application of these low-nickel stainless steels. We know what the new grades will do . . . let us help you put them to use. ***Allegheny Ludlum Steel Corporation, Oliver Bldg., Pittsburgh 22, Pa.***

WRITE FOR THE ASSISTANCE YOU NEED

1. "TECHNICAL STUDIES #3"

. . . essential information on the composition, properties, fabricating methods and applications of AL chromium-manganese, low-nickel stainless steels. *Write for your copy.*

2. TEST SAMPLES

. . . We'll be glad to supply engineering assistance, and actual samples of these 200-Series steels for testing under your processes and conditions.

ADDRESS DEPT. PE-76

For Stainless Steel in ALL Forms—call

Allegheny Ludlum

AL STAINLESS STEEL

WSW 8730

Warehouse stocks carried by all Ryerson Steel plants

Cleveland engineers were told long ago to start with the quality standards of the industry *and work up.*

The result is Cleveland's "Top Quality" that gives you a lot more for your standard and special fastener dollar:

Extra "Physicals" from revolutionary Cleveland-developed Kaufman *double extrusion* Process that cold forges cap screw from oversize wire, prepared under our own close metallurgical controls. *Result*—flow lines follow screw's contour, insuring strong crack-free heads, and threads with sturdy physical properties. Internal ductility is undisturbed, and screw has higher tensile and toughness.

Accurate Forming to extra-close tolerances, so they spin every time smoothly snugly into place . . . real cost saving on your production line! In-process and final inspection and testing guarantee quality.

Service? We maintain ship-at-once stocks of every kind and size we make. Ask your jobber for Clevelands, or check with us on production quantities. Write for current stock list.

The

CLEVELAND CAP SCREW

Company

2936 East 79th Street • Cleveland 4, Ohio
VUlcan 3-3700 TWX CV-42

WAREHOUSES:
CHICAGO • PHILADELPHIA • NEW YORK
PROVIDENCE • LOS ANGELES

See us at Design Engineering Show, Booth 324 and NAPA Inform-A-Show, Booth 237

Originators of the Kaufman DOUBLE EXTRUSION Process

E_o = Residual voltage
E_L = line voltage
t = time, in sec, after motor is disconnected

If elapsed time of t sec equals time constant T_o, then value of residual voltage E_o is 36.8 per cent of E_L, initial or maximum value. The value of E_o in $0.693T_o$ sec is 50 per cent of initial value of E_L. In another $0.693T_o$ sec, voltage will be 25 per cent of E_L. Again in as many seconds, 12½ per cent, and so on.

Calculation of T_o is simple when design values for insertion in Eq (1) are available. For example, calculations per stator phase for a 250-hp, 350-rpm, 440-v, three-phase, 60-cps cage motor of typical design show X_m to be 1.17 ohm; X_s, 0.0637 ohm; and R_s at test temperature 0.023 ohm. Calculations according to Eq (1):

$$T_o = \frac{1.17 + 0.0637}{377 \times 0.023} = 0.142 \text{ sec}$$

For a line-voltage frequency of 60 cps, time constant T_o is 8.52 cycles.

Test oscillogram indicating residual voltage decay after the motor breaker was opened is shown in Fig. 1. Since this test was made with motor unloaded, drop in motor speed for the short duration of residual voltage decay was negligible. To indicate nature of voltage decay, rms voltage information was taken from Fig. 1 and plotted as shown in Fig. 2. Time constant T_o can be located on this curve at 36.8 per cent of maximum voltage. Time constant can be readily calculated since at 50 per cent voltage, time is $0.693T_o$ sec. Motor residual voltage takes longer to drop to zero for larger horsepower motors, other characteristics being equal. Open-circuit

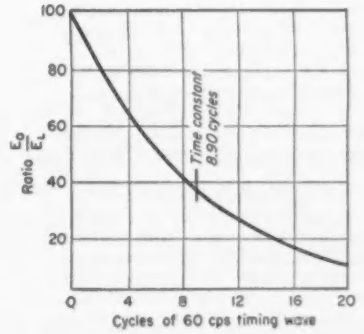


FIG. 2—Residual voltage decrement curve, plotted from information from test oscillogram of Fig. 1, has time constant at 36.8 per cent of maximum voltage

(Continued on page 399)

when a shim is

LAMINUM®

here are the advantages you get:

Shims stamped from LAMINUM® look and act like solid metal, but are made of laminations bonded together over their entire surfaces.

•

LAMINUM® comes in BRASS or STEEL (laminations .002" or .003") and in ALUMINUM (laminations .003")

REDUCED MACHINING COST:

You machine only to easy tolerances. The laminated shim is *adjustable*—you simply peel laminations of .002 inch or .003 inch with a penknife—to get exactly the spacing you need. You cut costs without sacrificing quality.

SIMPLIFIED USE:

Shims come to you in one "pack" for each application. They are precision-stamped to your exact specifications. No counting, no stacking, no miking. Gauge is always known. No dirt or grit can lodge between layers.

SPEEDED PRODUCTION:

Final fitting can be done right at the job. You don't have to take parts back and forth for further machining, grinding or filing. No special skill required. The laminations adjust spacing quickly, easily.

ADDED SERVICE FEATURE:

Throughout the life of the machines you produce, the simple removal of a shim lamination provides a unique adjustment for the take-up of wear. Original clearances can always be restored.

SEND TODAY for our Engineering Data File

LAMINATED SHIM COMPANY, INC.

1404 UNION STREET • GLENBROOK, CONNECTICUT

FLASH! Now also made of STAINLESS STEEL in layers of .002" or .003"

Yes, MM Engines are built and equipped to order

FURNISHED TO YOUR SPECIFICATIONS IN LOTS OF 1 OR 100!

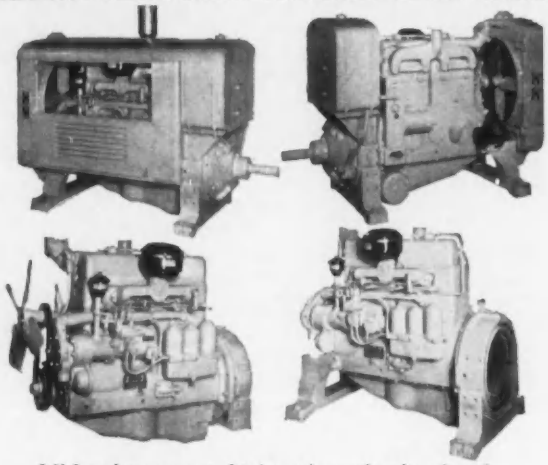
You get power adaption that fits your specifications more readily with Minneapolis-Moline engines. Why MM? Because, as an independent engine builder, no single sales outlet dictates MM engine design—and MM works in such a big variety of power applications.

To meet a wide range of basic requirements MM engines have large displacement for high torque at moderate rpm. Extra high compression and high turbulence combustion combined with high volumetric efficiency provide outstanding performance.

For these reasons MM units are ready to go when equipped with specified operating accessories. You eliminate major auxiliary unit purchases to adapt engine characteristics to meet momentary high load demands. Further long run benefits are low fuel consumption and low maintenance that total up to low cost production.

Every-day experience in supplying a wide range of unit requirements enables MM to maintain customary high quality in single or small lot quantities at reasonable cost.

A high degree of standardization results in high production parts that provide precision fits and permit MM to schedule parts for special units in large quantity, assuring early delivery and customer service.



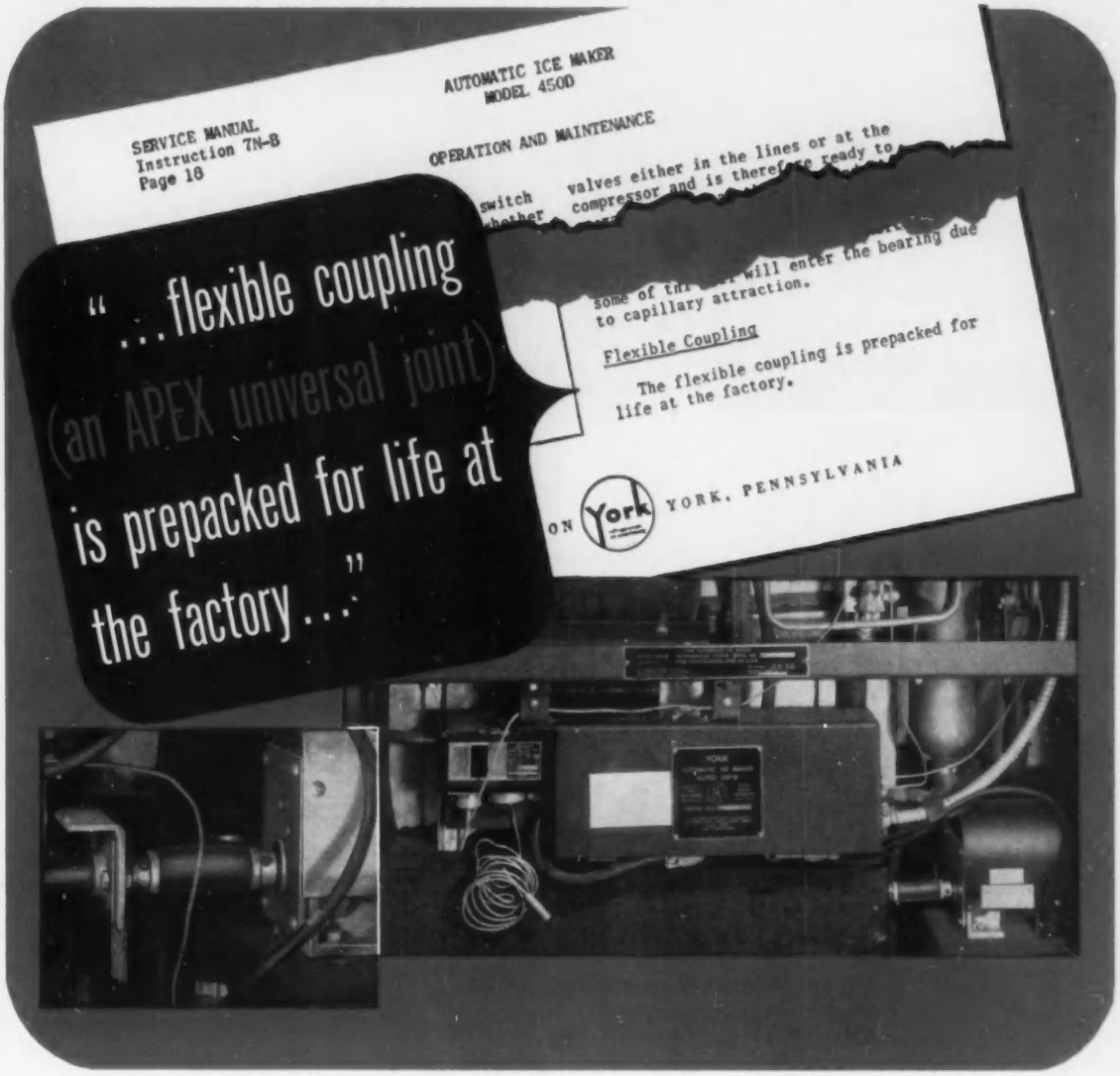
MM engines are completely engineered and equipped for gasoline, LP gas, natural gas, or distillate fuels. Sizes range from 206 cu. in. portable units to 1600 cu. in. stationary engines and are available for fan to flywheel application or completely enclosed leg mounted installations. MM also builds a line of industrial Diesel power units: Sizes—283-, 425-, 605 cu. in.

Standard equipment includes vacuum crankcase ventilation, thermostat controlled bypass cooling, packaged water pump, built in variable speed governors, enclosed gear driven oil pump, and oversize full-flow oil filters (shunt-type filters are provided exclusive on MM Thermo-Clad units).

Send details on your application for examples of MM built-to-order packages for original or replacement needs. Engineering service available for pumps, hoists, crushers, generators, shovels, ditchers, cranes, compressors, feed mills, saw mills, planing mills and similar installations. When you want dependable performance year after year from your engine, you want an MM Industrial Power Unit.

INDUSTRIAL DIVISION

MINNEAPOLIS-MOLINE MINNEAPOLIS 1, MINNESOTA


SERVICE MANUAL
Instruction 7N-B
Page 18
AUTOMATIC ICE MAKER
MODEL 45OD
OPERATION AND MAINTENANCE
Flexible Coupling
The flexible coupling is prepacked for life at the factory.
YORK, PENNSYLVANIA
"...flexible coupling (an APEX universal joint) is prepacked for life at the factory..."

The operation and maintenance instructions furnished with the York Model 45OD Automatic Ice Maker are as crystal-clear as the 8,000 cubes the machine can provide every 24 hours. Included in the section on lubrication is a very brief reference to the flexible coupling that joins the gear motor and the cam shaft: "The flexible coupling is prepacked for life at the factory . . ."

The flexible coupling in this instance is an Apex covered double universal joint, completely sealed to protect the joint and to provide clean, sustained lubrication.

Apex covered universal joints are used on a wide variety of industrial applications because they will operate efficiently under wet or dry, corrosive or abrasive conditions.

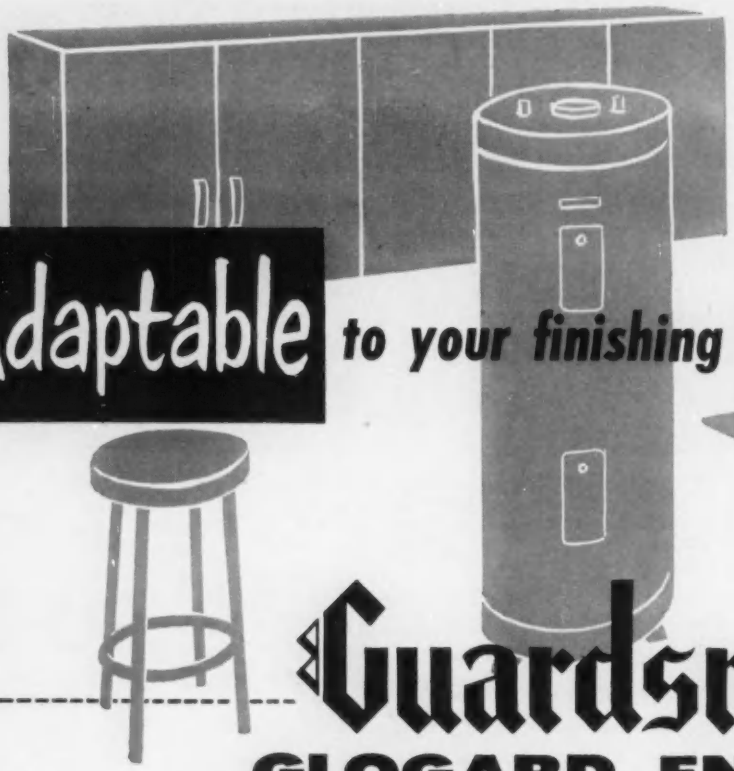
Their high overload capacity, lower deflection rate, superior fatigue resistance and high strength-weight ratio per size are other reasons why design engineers specify Apex universal joints to insure trouble-free service.

Our Catalog 27 and the very helpful U J Data Sheets will help you learn how Apex universal joints can help make yours a better product. Write, on your company letterhead please, for your copy.

APEX

industrial universal joints—3/8" to 4" diameters

THE APEX MACHINE & TOOL COMPANY
1039 S. Patterson Blvd. • Dayton 2, Ohio



Adaptable *to your finishing operation*

Guardsman®

GLOGARD ENAMELS

TYPE: Alkyd-Amino Resin

COLOR: White and tints

APPLICATION: Spray (reduce 5 parts enamel with 1 part SC #2 or Exlol)

BAKE: 10 to 30 min. at 300° or 5 to 15 min. at 325° (varies with formula)

GLOSS: Good

HIDING: Solid in one coat on steel

HARDNESS: HB to H pencil depending on formula

ADHESION: Good

COLOR RETENTION: Good

USES: Cabinets, water heater jackets, metal furniture and table. Also ideal for stools, containers, and other metal specialties wherever you require a high quality **competitive** finish.

The Better the Finish, the Better the Buy

GRAND RAPIDS VARNISH CORPORATION

MAKERS OF THE FAMOUS Guardsman® *FINISH AND* Guardsman® *CLEANING POLISH*

GRAND RAPIDS, MICHIGAN

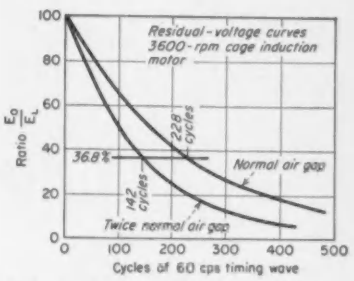


FIG. 3—Amount of decrease in open-circuit time constant resulting from increased air gap is indicated by curves.

time constant T_o increases with rated motor speed. Because of this, high-speed, two-pole motors have larger open-circuit time constants than comparable motors having more poles.

There can be wide variation in values of T_o for different motor designs even for same hp, speed and other characteristics. Two motors apparently identical in all respects often have different time constants. If required, a motor having a low time constant can be designed, and Eq (1) indicates factors involved. Value of rotor reactance X_r does not vary much in percentage among motors of larger than NEMA sizes. If rotor resistance R_r is increased, T_o will be reduced but so will motor efficiency.

Magnetizing reactance is largely determined by motor air-gap dimensions. Increase in air gap increases motor magnetizing current, decreases value of X_m and T_o and power factor is also reduced. Decrease in open-circuit time constant T_o shown Fig. 3.

Organic Corrosion

Abstracted from "Organic Corrosion," by B. S. Biggs, Chemical Research, *Bell Laboratories Record*, Jan. 1956.

The mechanisms by which oxygen damages a plastic or rubber is still a research problem. Studies reveal that oxidation of organic substances is usually a free-radical chain reaction—a reaction of molecular fragments with oxygen in such a manner that new centers of attack are produced in chain-like fashion as decomposition progresses. Although many of the details are not yet known, the damage can be appraised in its general aspects.

One of the principal effects of oxi-

(Continued on page 402)

For High Speeds
...this new
dynamically balanced
Waldron
COUPLING
An entirely new design . . . built of specially selected material . . . thoroughly tested for proper balance. Truly a precision made coupling in every respect, accurately machined to close tolerances. If yours is a high speed application, write for our descriptive Bulletin No. 52.
JOHN WALDRON CORP. • NEW BRUNSWICK, N. J.
Sales representative in Principal Cities
STANDARD TYPES
Waldron
COUPLINGS
SPECIAL TYPES

Leland motors make crashes pay off

Crashes here are good for business. But tough on motors. There's the obvious problem of shock—constant start and stop, arcing from the overhead pick-up, overloading in jam-ups.

Yet Leland engineers have designed and built a motor so ideally suited to the job that two of the nation's largest producers of this type of playland equipment use Leland motors exclusively. And have for years.

A soundly engineered Leland motor is a good bet to make *your* product "pay off." Better investigate Leland's complete line of standard motors, from ⅛ to 5 hp—soon up to 20 hp—in all popular types and enclosures. Contact us today.

Illustrated is a Leland fractional hp, 115/ 230 v ac drip-proof, ball-bearing, repulsion-start induction-run motor.

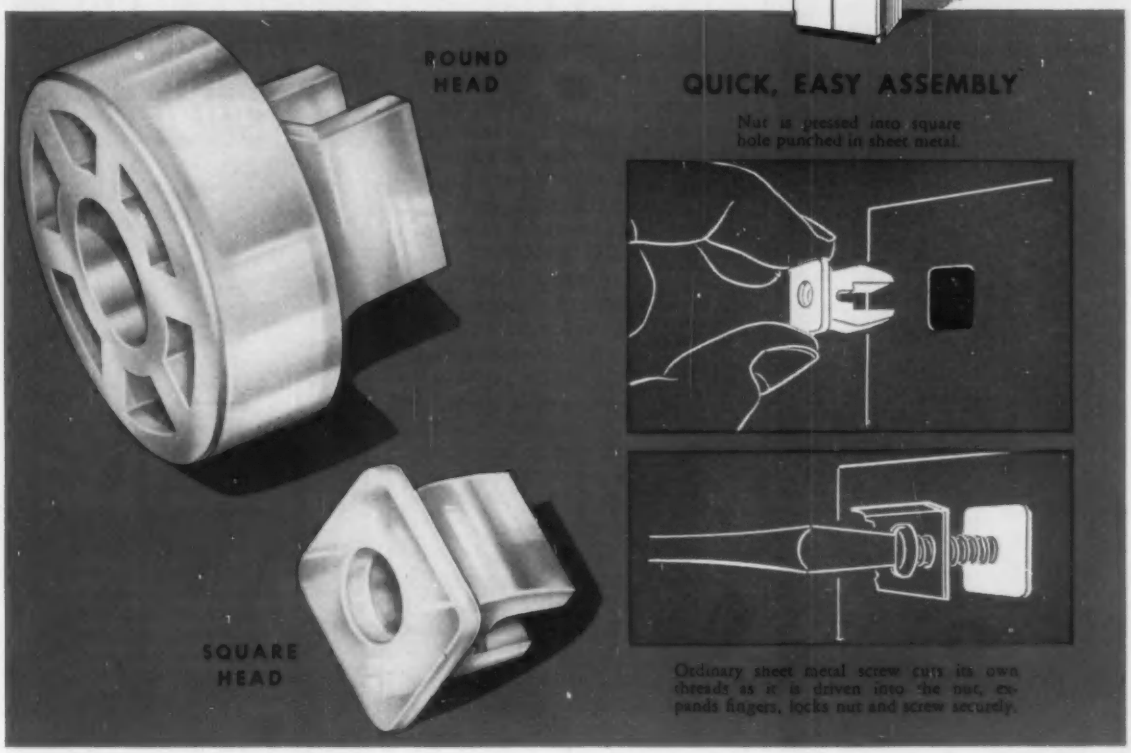
Another AMF Product

LELAND MOTORS

THE LELAND ELECTRIC COMPANY
Dayton 1, Ohio
Division of AMERICAN MACHINE & FOUNDRY COMPANY

How many ways can **you** use

DOT PLASTIC *snap in* NUTS?


ROUND HEAD
SQUARE HEAD
QUICK, EASY ASSEMBLY
Nut is pressed into square hole punched in sheet metal.
Ordinary sheet metal screw cuts its own threads as it is driven into the nut, expands fingers, locks nut and screw securely.

United-Carr's new self-locking, plastic nut is designed for blind application and can be used with all types of metal finishes without scratching or chipping the surface. Its plastic fingers provide rigid anchorage yet will not mar paint, polished metals or even porcelain.

Inexpensive sheet metal screws cut their own threads and expand the nut's fingers as they are driven, locking both nut and screw tightly in place. Screws can be removed and replaced several times without damage to the nut.

DOT plastic snap-in nuts are electrically non-conductive and provide a high degree of insulation against heat transfer. For all practical purposes, they also provide an effective vapor seal.

Available in several styles and sizes. Write for full information and samples or contact your nearest United-Carr representative.

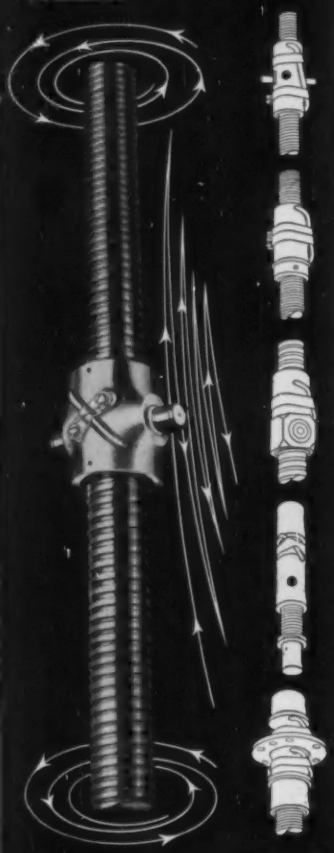
UNITED-CARR FASTENER CORP.

CAMBRIDGE 42, MASSACHUSETTS

MAKERS OF DOT FASTENERS

beaver
ball screws

Successor to the Acme screw drive and preferred in many applications to hydraulic and pneumatic systems. Guaranteed 90% efficiency in converting rotary twist to linear push (or vice versa). Employs a stream of precision balls and ground lead to eliminate drag and wear in delicate instruments to massive wind tunnel jacks. Any diameter or travel: indexing, inching, traversing. Literature, consulting engineering service available.



Fastest growing source for ball screws

Beaver Precision Products INC.
CLAWSON, MICH.

dation is to cut the polymers or large molecules, of which plastics are composed, into smaller pieces, thereby weakening the whole structure. Another effect may be to lower the value of a polymer as electrical insulation. A third may be to introduce more ties or "cross-links" than were originally present, thus impairing the flexibility and toughness afforded by a nice balance in the inter-molecular forces. Increasing greatly the number of cross-links tends to make the material glassier or more brittle, particularly when accompanied by a shortening of the average length of the molecules. Ultimately the material may craze, or crack, and the surface may chalk away. Erosion of the surface of polymers outdoors occurs particularly in those materials which, at very low molecular weight, tend to be soluble in water—the cellulosics, for example.

The only sure way of learning how a material will age outdoors is to expose it outdoors and wait. This is an excellent procedure for screening out those materials which deteriorate rapidly (and unfortunately many polymers fall in this category), but it is obviously impractical to wait the required number of years for the evaluation of compounds which are usefully resistant to outdoor exposure. It is only when a new material becomes available in experimental quantities years before it reaches commercial production or before it is needed that a reassuringly long history of outdoor exposure can be obtained in time to be useful, and even then this information must be reinforced with results from accelerated tests.

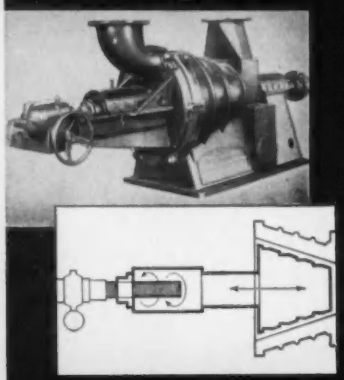
Ovens operated at elevated temperatures and sun lamps or carbon arcs are devices commonly used in accelerated aging. With such apparatus it is sometimes possible to produce in a week or two in the laboratory a state of deterioration reached outdoors after a year or more. Changes are detected by very careful measurement of physical and electrical properties.

Another accelerated method which can be used in a laboratory is volumetric measurement of the oxygen absorbed. If the sample is maintained at an elevated temperature in a closed system which includes a gas burette, and the system is filled with oxygen, the consumption of the gas can be

(Continued on page 406)

The same device that operates wing flaps

helps make paper stronger



Beaver Ball Screw mechanisms have been selected by Shartle Bros. Machine Division, Middletown, Ohio, for the control unit in their line of jordaners and refiners used in paper manufacture.

WHY? Because Beaver Ball Screws permit fast adjustment for change of stock characteristics by affording easiest manipulation and most positive positioning of the plug.

Can your product be made more efficient with Beaver Ball Screws? Write for literature.

Beaver Precision Products INC.
CLAWSON, MICH.

use Porcelain Enamel

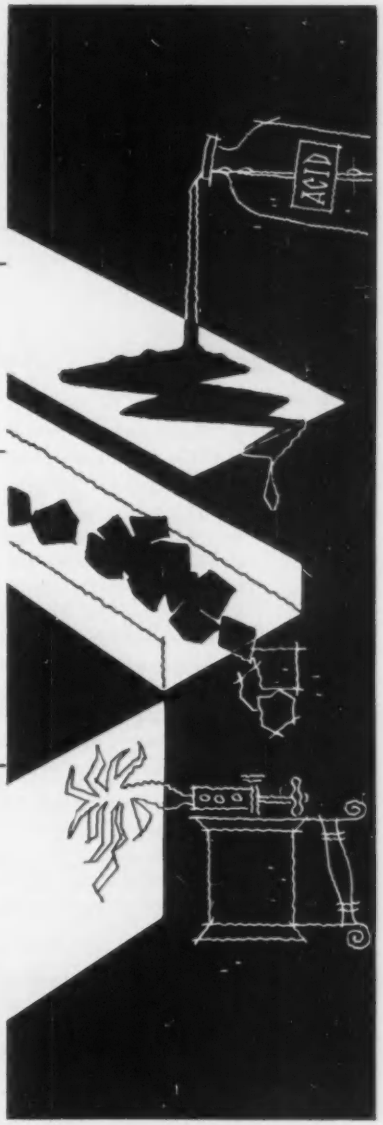
to protect your products

against:

corrosion

abrasion

high temperatures



No other finish can give the protection afforded by Porcelain Enamel! This completely inorganic material, combining the strength of steel with flint-hard glass, is unaffected by conditions that would wear-out, rust-out or burn-up other materials. By using Porcelain Enamel in critical applications, designers improve the performance of their products, and at the same time frequently reduce weights and lower costs.

And where beauty and color are desired to increase the attractive appearance and sales appeal of a product, Porcelain Enamel fills every requirement. It is unsurpassed in range of colors and surfaces, and retains its original beauty and color *for life*!

We will be glad to help you use this modern material to make *your* products more serviceable, more durable, more salable.

Lifetime PORCELAIN ENAMEL
PORCELAIN ENAMEL INSTITUTE, INC.

This message sponsored by the Frit Division of the

PORCELAIN ENAMEL INSTITUTE, INC.

1145 Nineteenth Street, N. W. • Washington 6, D. C.

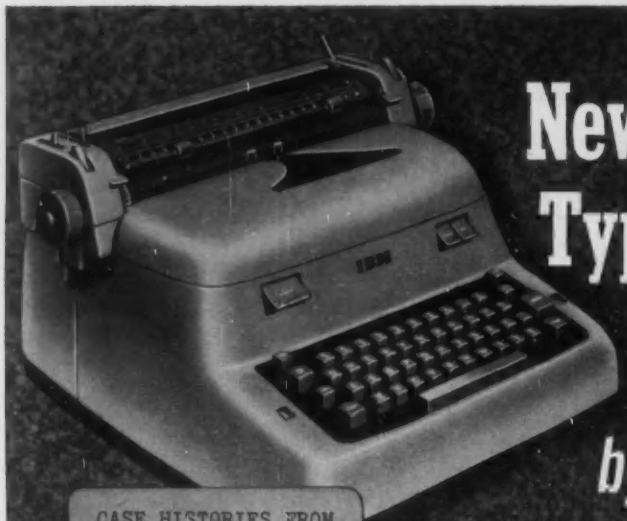
PORCELAIN ENAMEL INSTITUTE, INC.
1145 Nineteenth Street, N. W., Washington 6, D. C.

Please send me design information about PORCELAIN ENAMEL for possible application to_____
(type of product)

Name_____

Company_____

Address_____



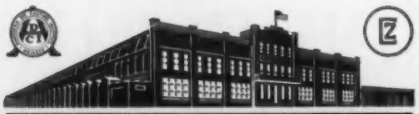
New IBM Electric Typewriter *dressed up in Die Castings by* MT. VERNON

CASE HISTORIES FROM MT. VERNON FILES

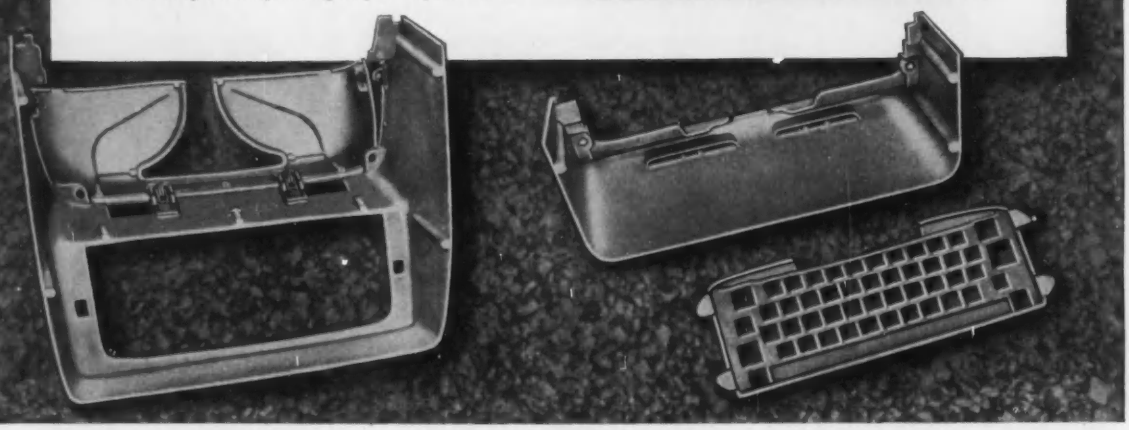
"New from carriage to keyboard, and years ahead in results, performance, design," is how IBM describes its new electric typewriter. And as with any leader in manufacturing, "new in design" at IBM means best in manufacturing methods. That's why this electric marvel is housed in die castings. Note how only four strong, thin-walled, large aluminum sections are used to completely enclose the complex machinery in a handsome example of modern styling. Note particularly the accurately-fitting sections and keyboard, and gracefully-rounded contours, always a delight to the eye, but often a manufacturing headache.

Not so, however when you use Mt. Vernon die casting — the modern, high-speed, low cost production method that produces the most intricate parts, frequently so flawlessly perfect that only a final painting step is required before assembly. Best of all is the complete service available from Mt. Vernon's coordinated designing, die-making, casting, and machining facilities, all under one roof, which can supply die cast zinc and aluminum parts ready for use; reducing need for machining and finishing.

A switch to die casting or to a complete die casting service like ours, may be your next step. Let's discuss it.



MT. VERNON
DIE CASTING CORP.
STAMFORD, CONNECTICUT



SALES REPRESENTATIVES

Mr. Grant Eller
6 East 194th St., Cleveland, Ohio

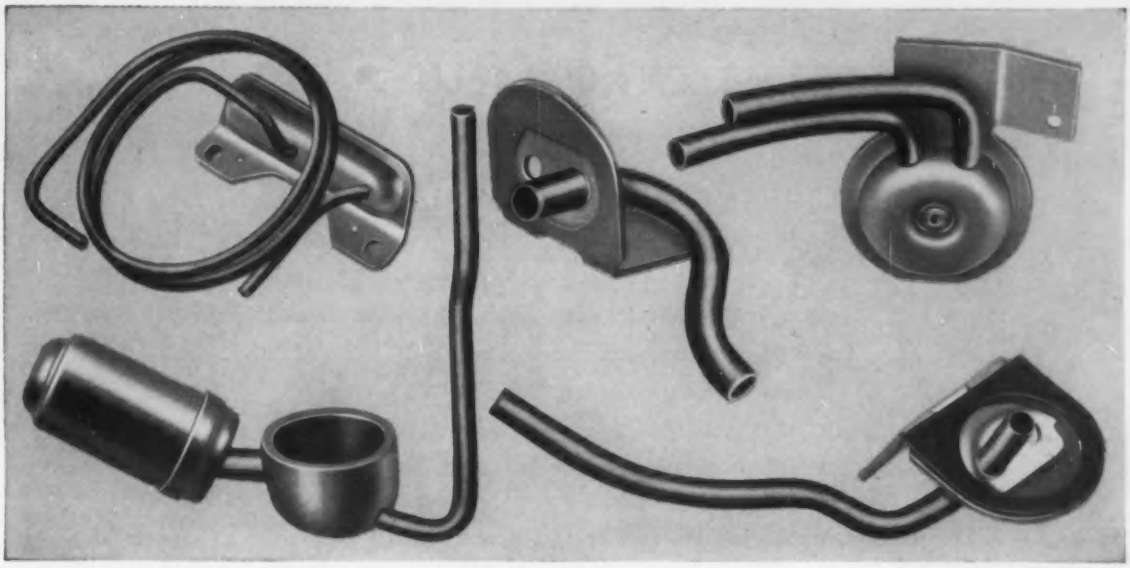
Mr. David King
230 Grant Boulevard, Syracuse, N. Y.

Mr. William Sauers
101 Briarcliff Road, Rochester, N. Y.

Mr. Arthur Diamond, Tools Incorporated
86 Bethlehem Pike, Philadelphia, Pa.

Mr. Jerome J. Theobald
9 East Genesee St., Skaneateles, N. Y.

Mr. George E. Hahl
39 South Munn Ave., East Orange, N. J.



Here is a small sampling of the variety of tubing parts produced for Bundy customers. Many of them involved close cooperation between Bundy engineers and the customers, in solving problems of design and function. Are your tubing designs simple or complex? Do they call for serpentine coils, swaging, flattening, expanding, brazing, saddle jointing, bending to small radii, piercing, upsetting, slotting, threading, angle cutting, notching, flanging, flaring, reducing, tapering, other fabrication operations, or combinations of the above? Come to Bundy for the industry's most reliable tubing, most helpful engineering talents, and most versatile fabrication facilities.

Bundyweld Tubing can be fabricated to virtually any design you can dream up

There's no tubing problem big enough to be a design bottleneck when you work with Bundy

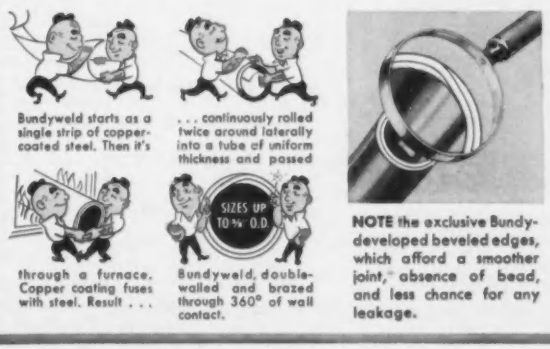
Most designers know that Bundy is the leader in small-diameter steel tubing. Many know that Bundyweld Tubing is double-walled from a single strip, to give it unusual properties found in no other type of tubing.

But what we want designers to know, above all, is that Bundy can be of tremendous help at the design stage of any product which utilizes tubing. We offer this help.

Take advantage of this unbeatable combination: expert, free engineering service plus genuine Bundyweld Tubing, double-walled but stronger; high thermal conductivity; high bursting strength; takes easily to any fabrication.

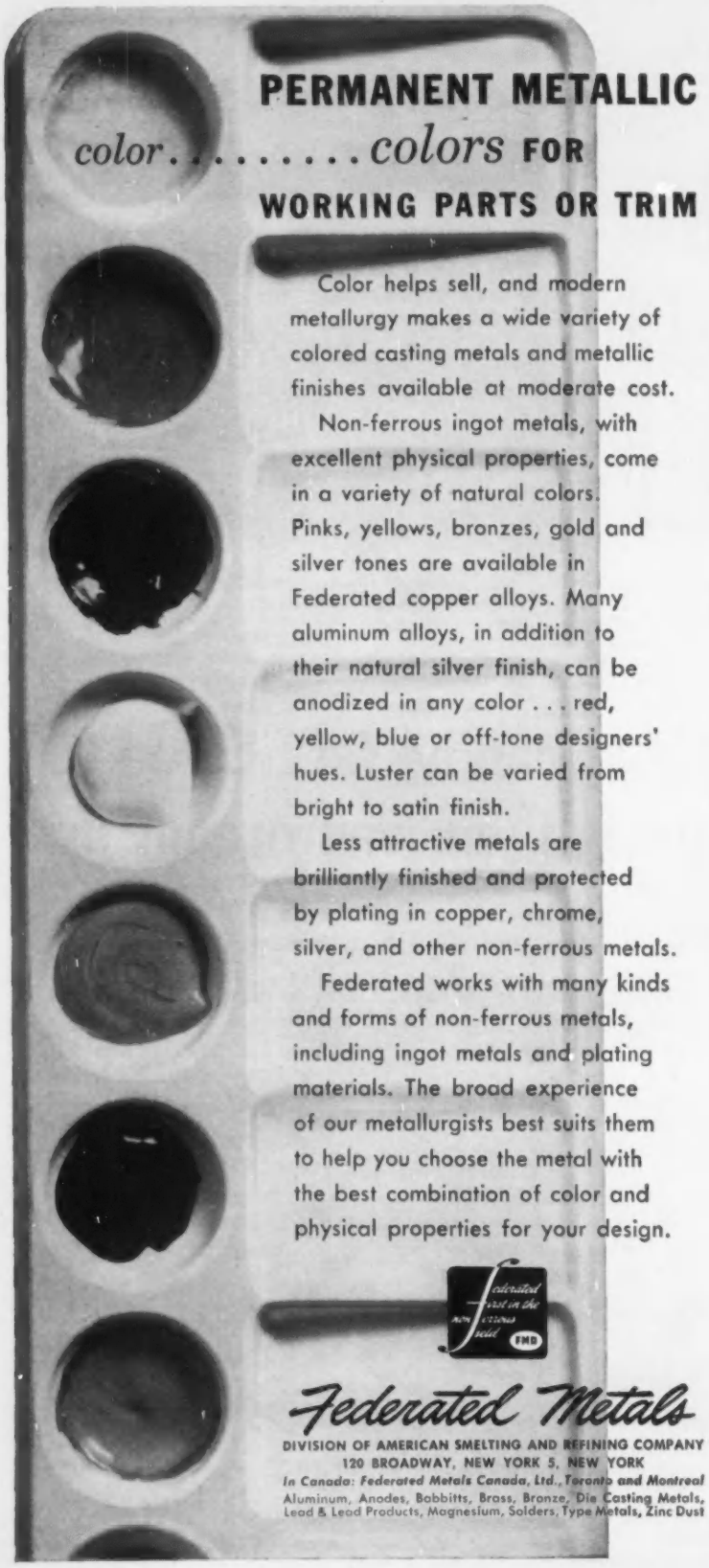
Bundy can help you with that tubing problem. Call, write, or wire today!

BUNDY TUBING COMPANY
DETROIT 14, MICHIGAN


Bundyweld starts as a single strip of copper-coated steel. Then it's
. . . continuously rolled twice around laterally into a tube of uniform thickness and passed
through a furnace. Copper coating fuses with steel. Result . . .
SIZES UP TO ⅝" O.D.
Bundyweld, double-walled and brazed through 360° of wall contact.
NOTE the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

BUNDYWELD TUBING®

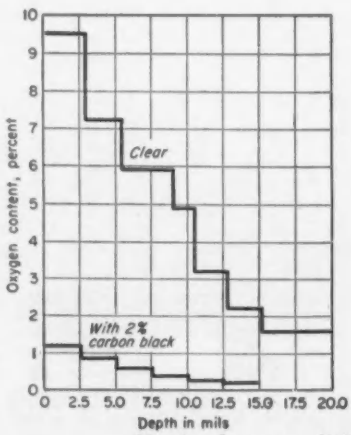
DOUBLE-WALLED FROM A SINGLE STRIP


PERMANENT METALLIC
color.....colors FOR
WORKING PARTS OR TRIM
Color helps sell, and modern metallurgy makes a wide variety of colored casting metals and metallic finishes available at moderate cost.
Non-ferrous ingot metals, with excellent physical properties, come in a variety of natural colors. Pinks, yellows, bronzes, gold and silver tones are available in Federated copper alloys. Many aluminum alloys, in addition to their natural silver finish, can be anodized in any color . . . red, yellow, blue or off-tone designers' hues. Luster can be varied from bright to satin finish.
Less attractive metals are brilliantly finished and protected by plating in copper, chrome, silver, and other non-ferrous metals.
Federated works with many kinds and forms of non-ferrous metals, including ingot metals and plating materials. The broad experience of our metallurgists best suits them to help you choose the metal with the best combination of color and physical properties for your design.
Federated first in the non-ferrous field
FMD
Federated Metals
DIVISION OF AMERICAN SMELTING AND REFINING COMPANY
120 BROADWAY, NEW YORK 5, NEW YORK
In Canada: Federated Metals Canada, Ltd., Toronto and Montreal
Aluminum, Anodes, Babbitts, Brass, Bronze, Die Casting Metals, Lead & Lead Products, Magnesium, Solders, Type Metals, Zinc Dust

measured by the change in level in the burette. This method is particularly useful for detecting the time of onset of rapid reaction which marks the beginning of the end, and which usually comes after a period of very slow reaction known as the "induction period." It has been known for many years that certain chemicals added to the polymer are capable of prolonging the induction period.

These substances, called anti-oxidants, are "getters" or traps for free-radicals, and in effect interrupt the chain reaction in an early stage. Each molecule of anti-oxidant, in its sacrificial reaction with a free-radical, may thus save as many molecules of the substance being oxidized as would otherwise have been attacked in the chain reaction started by that particular radical. This saving sometimes runs into hundreds of molecules for each free radical caught, which means that the rate of thermal oxidation in the presence of anti-oxidant may be less than 1/100 of that of the pure material. The volumetric oxygen absorption method is an excellent one for evaluating anti-oxidants and for determining relative susceptibility to oxidation. Obviously it cannot be applied to field samples.

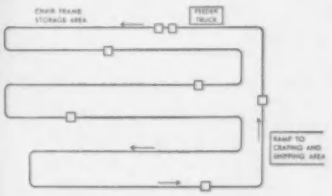
A method which is now coming into use for measuring the extent to which oxygen has combined with organic material is that of direct analysis for oxygen content. Until recently oxygen was determined in organic substances by difference; that is, analyses were made for all other elements present and the difference between the total percentage of these and 100 per



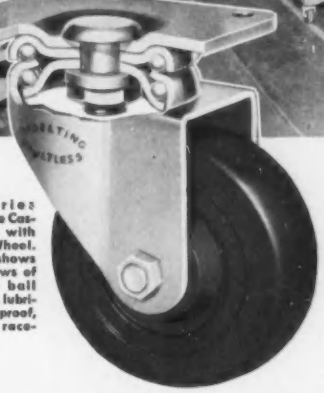
(Continued on page 410)

NOELTING **Faultless** **CASTER** MATERIALS HANDLING **FACTS**

CONTINUOUS PRODUCTION LINE STEPS UP OUT-PUT AS MUCH AS 25% TO 40% PER DAY AT LENOIR CHAIR COMPANY DIVISION OF BROYHILL FURNITURE FACTORIES



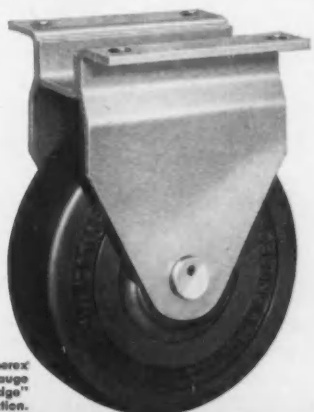
Here is the Faultless way for any plant to control costs and increase sales. In this case, chair frames and upholstering materials start at a given point and arrive at the crating area precisely as timed. Faultless Industrial Casters keep the all-steel trucks moving without interruption. Trucks are attached to a continuous under-floor chain drive that automatically flows through an entire series of work stations . . . maintaining predetermined costs . . . providing the sales department with quicker deliveries and competitive prices.



1100 Series Swivel Plate Caster shown with Ruberex Wheel. Cut away shows two full rows of hardened ball bearings in lubricated, dust-proof, hardened raceways.

Here, again, a prominent manufacturer of fine products employs dependable Faultless Casters throughout a complete production line system. As a result, the Lenoir Chair Company, Upholstering Division of Broyhill Furniture Factories, has enjoyed a considerable increase in the numbers of units processed per day in this plant. This efficient system is based upon the use of 3′ x 3′ all-steel trucks pulled around a 1200 ft. cycle of work areas by a continuous under-floor chain. Faultless Double Ball Bearing 1121-4TG Swivel, and 1721-4TG Rigid Plate Casters are standard equipment on the trucks. The resulting improvement in production schedules of chairs and sofas, and the reduction in man-hours per unit have been considered remarkably successful. Faultless 1100 Series Casters have a king bolt micrometer adjustment of swivel raceways to suit individual conditions. Hardened and polished ball bearings and large diameter hardened raceways that are factory lubricated, assure friction-free movement and long life.

This operation at Lenoir Chair Co. is typical of thousands of Faultless Caster handling operations. Faultless 1100 Series Swivel and 1700 Series Rigid Plate Casters are ideal for light-medium duty operations such as this one, where dependability of equipment is extremely important. Thread guards on each caster prevent winding of textile ravelings around wheel axles and assure hour-after-hour uninterrupted operation. Faultless cushion Tread Ruberex Wheels assure quiet operation and the plant's smooth cement floors are protected against wearing and chipping.



1700 Series Rigid Type Caster with Ruberex Wheel. Horn, consisting of two heavy gauge steel side members and welded "Bridge" member, is especially strong construction.

FAULTLESS CASTER CORPORATION
EVANSVILLE 7, INDIANA
Offices in Atlanta, Baltimore, Boston, Buffalo, Chicago, Cleveland, Dallas, Detroit, Grand Rapids, High Point, Indianapolis, Los Angeles, New Orleans, New York, Philadelphia, Portland, Seattle, St. Louis, Canada: Stratford, Ontario.

MAIL THIS COUPON TODAY

FREE Faultless Industrial Caster Data now ready for you, no obligation. **Dept. PR-4**

- ☐ File Folder of Caster Specifications
- ☐ Wall Chart of Caster applications

Name_____

Firm_____

Title_____

City_____ State_____

THE Y-4 PERISCOPE BOMBSIGHT *used in B-47 Stratojets has 3,433 parts, nearly 2,000 of them in this head-end assembly alone. General Mills manufactures this precision instrument in quantity under a USAF prime contract.*

No need to swamp your staff with piece part and assembly problems...

Let General Mills supply the whole package

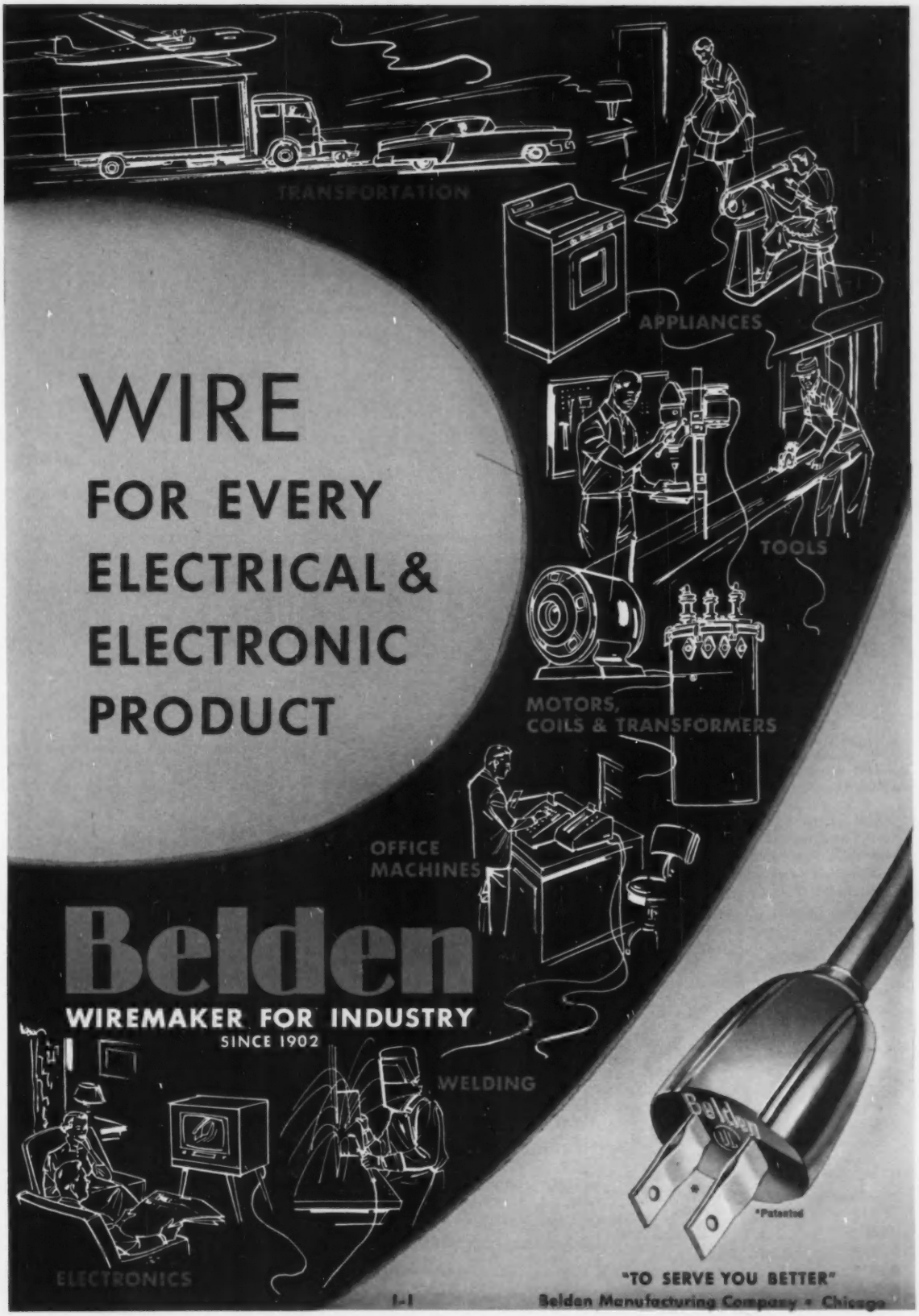
Eliminate the thousands of detail problems involved in turning out complete electro-mechanical assemblies—and save money, too!

The Mechanical Division of General Mills is ready to manufacture or purchase component parts, assemble to your requirements, and deliver assemblies performance-tested to rigid Government standards—on time. We have the experience and equipment required to take over the complete job. The highest precision standards are maintained in engineering, manufacture, quality control, packaging and accounting.

LET US BID on your requirements. Write, wire or phone: Dept. PE-3, Mechanical Division of General Mills, Inc., 1620 Central Ave., Minneapolis 13, Minn. STerling 9-8811.

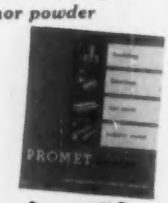
Job opportunities available for creative engineers. Work closely with outstanding men on interesting projects.

MECHANICAL DIVISION OF General Mills


TRANSPORTATION
APPLIANCES
WIRE
FOR EVERY
ELECTRICAL &
ELECTRONIC
PRODUCT
TOOLS
MOTORS,
COILS & TRANSFORMERS
OFFICE
MACHINES
Belden
WIREMAKER FOR INDUSTRY
SINCE 1902
WELDING
ELECTRONICS
*Patented
"TO SERVE YOU BETTER"
Belden Manufacturing Company • Chicago

Special formulas, developed for specific or unusual conditions, assure the best combination of physical properties. Will not cut, or stick to the shaft under ordinary operating conditions, nor powder under the most severe service.

Send for free literature and service data sheets.



THE
American Crucible
PRODUCTS CO.

"Bearing Specialists Since 1919"

1317 OBERLIN AVENUE, LORAIN, OHIO, U.S.A.

Please send free literature and service data sheets on Promet Bronze.

NAME_____
COMPANY_____
STREET_____
CITY & STATE_____

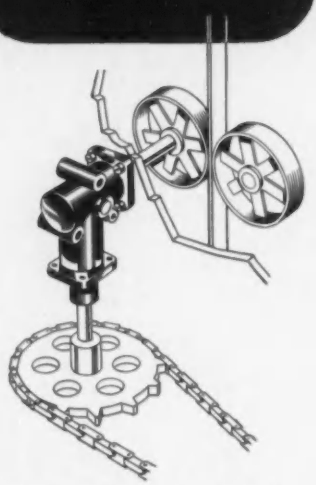
cent was assumed to be oxygen. In recent years, direct methods based on quantitative conversion to carbon monoxide have been perfected so that it is now possible to measure the oxygen content of deteriorated material without including the errors in the analyses of all the other components. The accompanying graph shows the oxygen content of successive layers beneath the surface of polyethylene after irradiation with a carbon arc for 1000 hr. In one case the polyethylene contained no additive and in the other it contained 2 per cent of well-dispersed carbon black. The successive layers were sliced off with a microtome. The data in the graph not only illustrate the usefulness of this method in detecting the extent of oxidation but re-emphasize the value of opaque substances in protecting organic materials from photo-oxidation. Antioxidants are of only small benefit here. The only effective method yet found for protecting organic polymers from sunshine for long periods of time is the incorporation of light-absorbing substances. Although in general the best protector is carbon black, several other pigments and a few organic light absorbers have been found helpful in special cases.

While oxygen is the most prevalent enemy of organic matter, there are other substances in the normal atmosphere which are sometimes important —ozone and water vapor. Several polymers in commercial use, notably natural rubber and the synthetics based on butadiene, contain a type of chemical grouping referred to as "unsaturation" in which one carbon atom is depicted by chemists as tied to another by two bonds instead of one. This is a reactive arrangement, particularly with ozone, and rubbers containing such groupings, when stretched in the presence of even the minute amounts of ozone found in the air, are apt to develop many cracks running transverse to the direction of stretch. Almost everyone has seen such cracks along folds in rubber gloves or old inner tubes, at bends in laboratory rubber tubing, or in garden hose. A discussion of this reaction has been published previously. (Bell Laboratories Record, March, 1948, pp. 119.)

The other most common degrada-

(Continued on page 414)

Here's an angle that's RIGHT for you!



There's an ANGLgear to solve virtually any right-angle power take-off problem.

Whatever your 90° take-off problem, there's an ANGLgear to meet it which will eliminate the necessity of resorting to a high cost, unwieldy custom-made unit. In either manual or power operated control systems, design engineers are intrigued by the small size, light weight, and *high capacity* of ANGLgears.

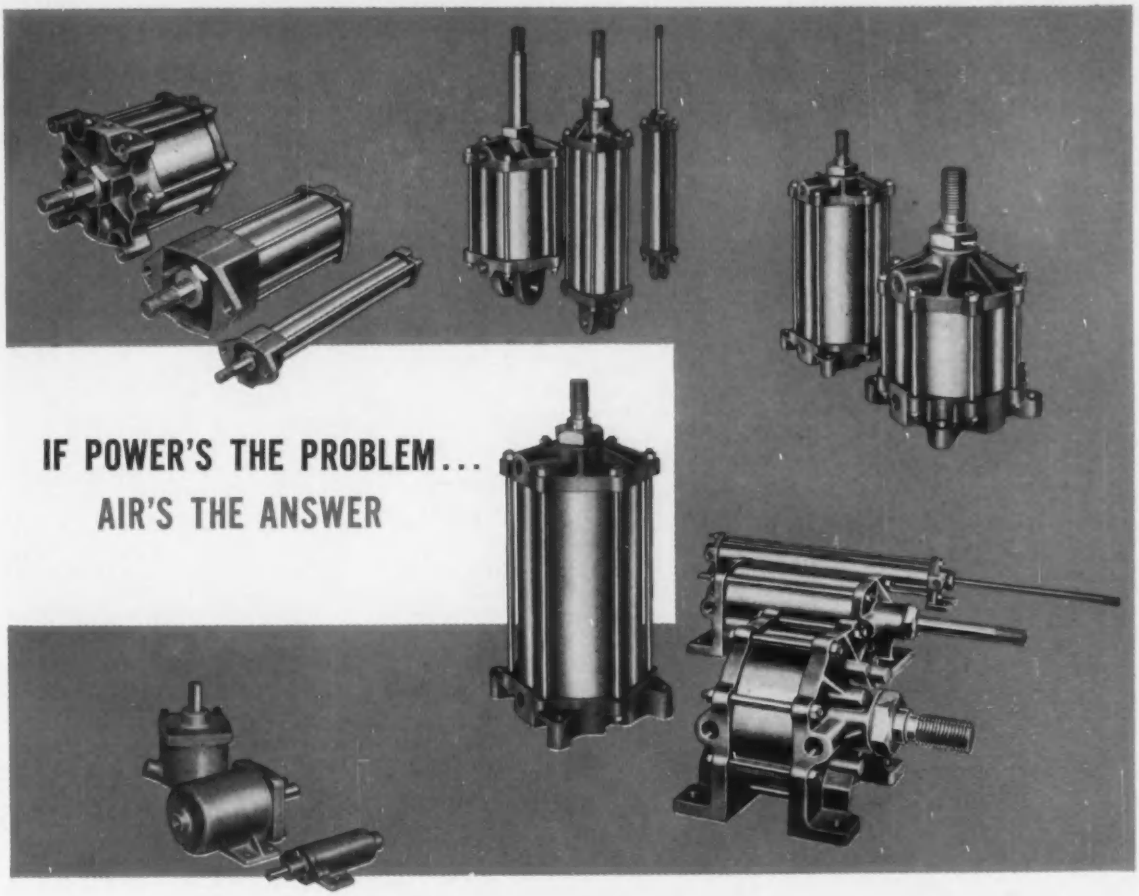
Models 340 (2-way) and 350 (3-way), rated at 3 hp at 1200 rpm, will transmit a maximum static torque of 2500 lb. in. Constructed with durable Coniflex* gears and lubricated for life, precision-made ANGLgears are the most versatile right-angle units available.

See our literature in the product design file of Sweet's Catalog—then contact your local distributor, or write us for information.

*TM The Gleason Works, Rochester, N.Y.

AIRBORNE

AIRBORNE ACCESSORIES CORPORATION
HILLSIDE 5, NEW JERSEY



Let Schrader air cylinders do the work

There is a Schrader Air Cylinder with power enough to meet any application. Ideally suited to pushing . . . pulling . . . lifting . . . lowering . . . wherever repetitive operations are required —Schrader Cylinders are used in innumerable applications in industries of all types.

Schrader has a complete line of cylinders that will meet any requirement. They are available in single or double acting, in bores up to 8" diameter, in any stroke, and in any type of mounting.

Schrader Air Cylinders will deliver controlled low-cost power to eliminate manual effort and for incorporation in automation designs. They make hard work easy and speed up production.

Don't forget, the complete Schrader line includes operating and control valves of every type, as well as all other compressed air accessories for air systems.

Write for Schrader Cylinder Specification Data or for information on the complete line of compressed air accessories.

Schrader
REG. U. S. PAT. OFF.

LEADERS IN AIR CONTROL SINCE 1844

The complete Schrader line of pneumatic accessories includes everything you need

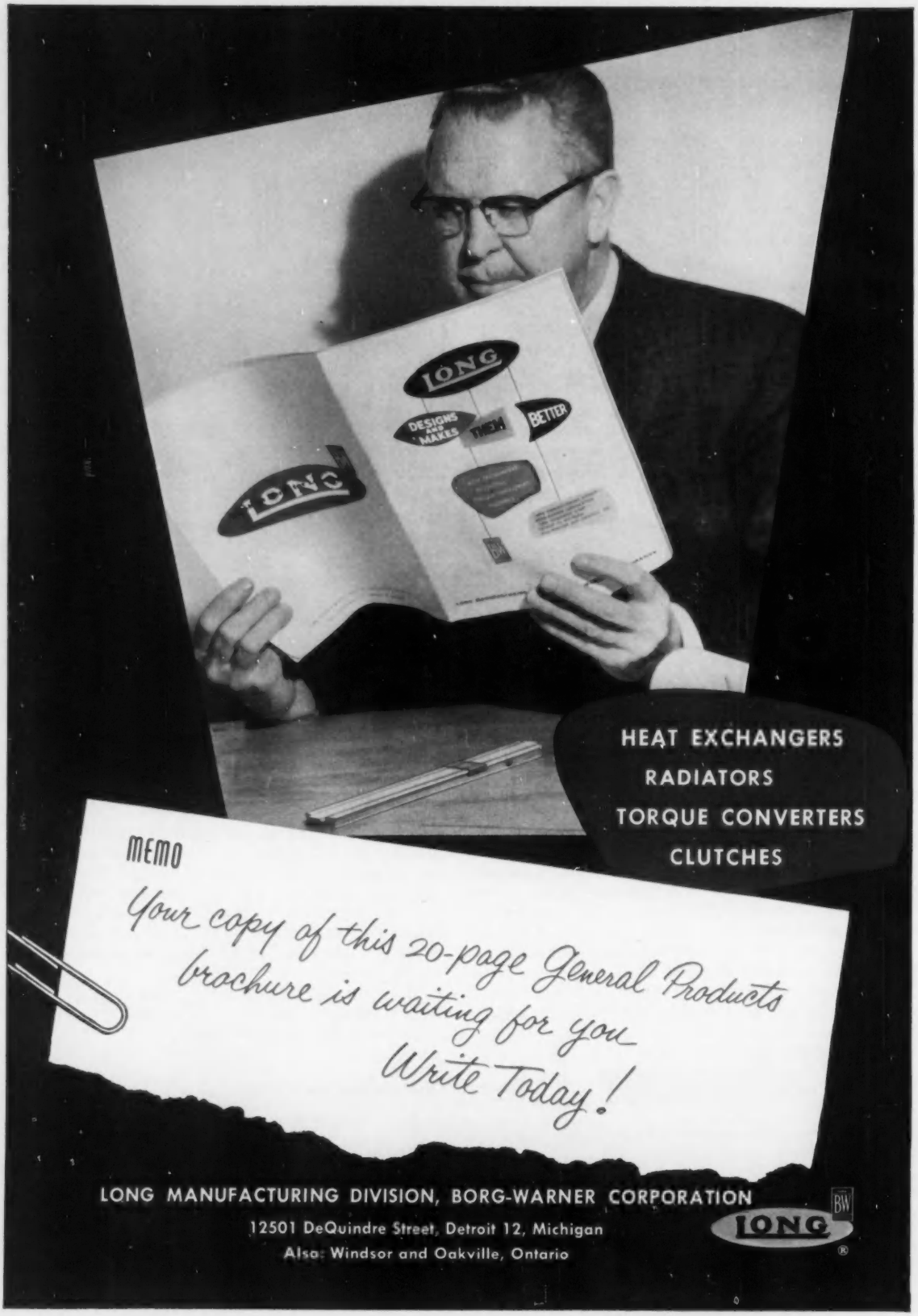
A. SCHRADER'S SON
Division of Scovill Manufacturing Company, Incorporated
477 Vanderbilt Ave., Brooklyn 38, N. Y.

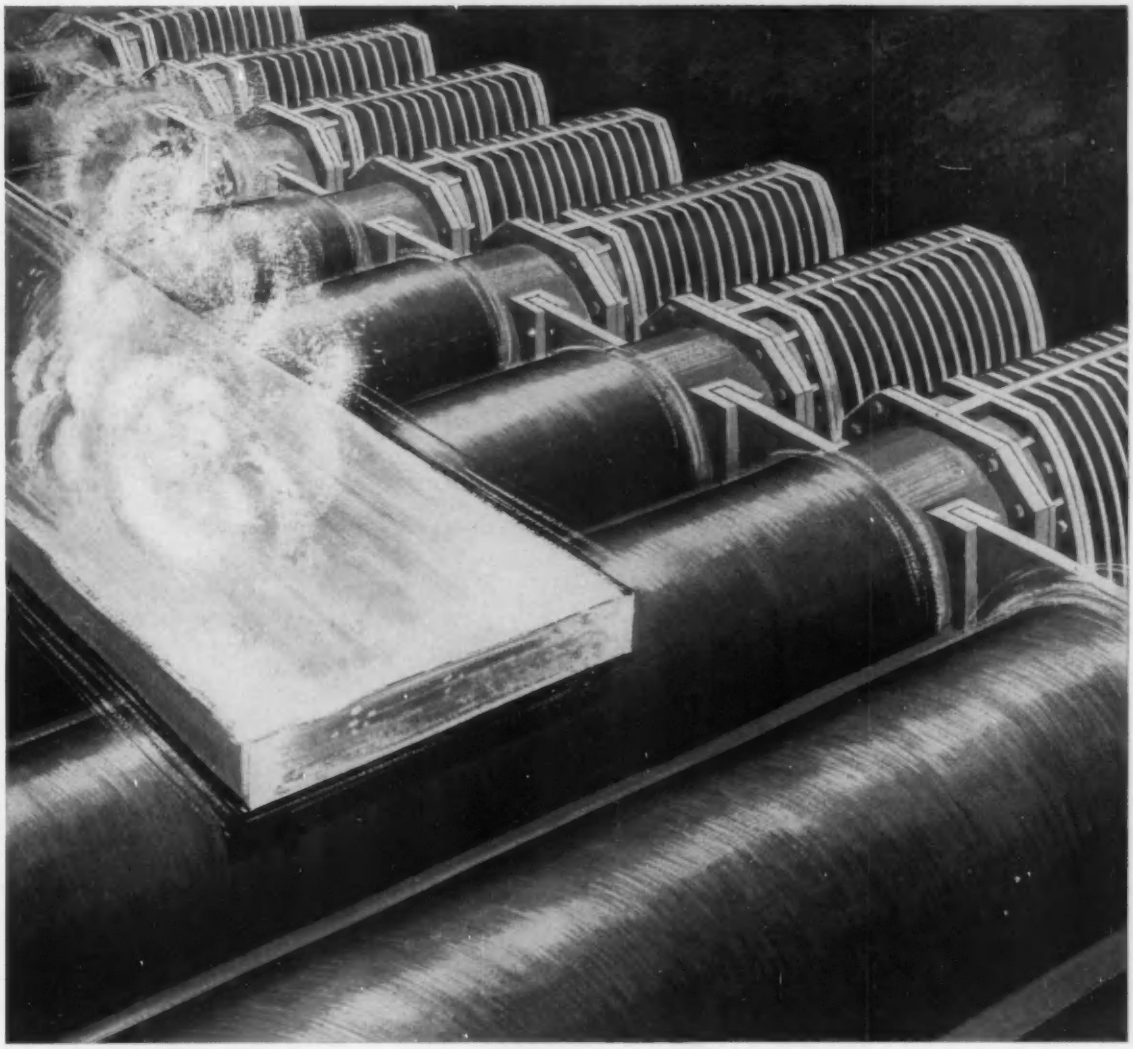
I am interested in more information on_____

Name_____ Title_____

Company_____

Address_____


LONG
DESIGNS AND MAKES
BETTER
LONG
HEAT EXCHANGERS
RADIATORS
TORQUE CONVERTERS
CLUTCHES
MEMO
Your copy of this 20-page General Products brochure is waiting for you
Write Today!
LONG MANUFACTURING DIVISION, BORG-WARNER CORPORATION
12501 DeQuindre Street, Detroit 12, Michigan
Also: Windsor and Oakville, Ontario
BW
LONG



LOEWY individually-driven motor-rollers eliminate production shut-downs

How much production is lost in *your* mill when line-shaft-driven table-rollers break down?

You can eliminate these costly shut-downs forever by installing Loewy individually-driven motor-rollers. These table-rollers are interchangeable—quick, easy to install. Straight or curved conveyor lines can be formed as required.

Consider these advantages of Loewy motor-rollers:

- **No need for generator or transformer. Units connect directly to AC feed line.**
- **Specially designed motor has high starting torque and is ideal for start-stop operation. Can be stalled temporarily under full load without damage.**
- **Roller speed adjusts automatically to weight of load.**
- **No gearing required—virtually no maintenance.**
- **Never a roller shut-down; rollers will idle in case of emergency.**

Loewy motor-rollers are available in a variety of sizes, for handling hot material in structural mills, for merchant mills, slabbing mills, pipe mills and for every heavy-duty application. Get the details about this rugged equipment. For your copy of the motor-roller bulletin, write to us at 350-Z Fifth Avenue, New York 1, New York.

BALDWIN BLH LIMA-HAMILTON

LOEWY-HYDROPRESS
BALDWIN-LIMA-HAMILTON

DIVISIONS: Austin-Western • Eddystone • Hamilton • Electronics & Instrumentation • Lima • Madsen • Loewy-Hydropress • Pelton • Standard Steel Works

Stop Aluminum Corrosion!

Insure Paint Adhesion

Provide Ornamental Finish

TURCOAT 4178

(Aluminum Surface Conversion Coating)

DOES ALL THREE!... Fixes Immediately, Too

Here's a process that provides *aluminum* with an ornamental, paint-gripping, corrosion-resistant coating... and does it faster and better!

Turcoat 4178 works on the surface conversion principle... that is, the coating is partially derived from the metal itself. Thus, coating and metal are *firmly interlocked*... even in tiniest crevices. The coating is a light golden color that imparts a special beauty when used for decorative purposes.

One user reports that square footage processed has *doubled* since the installation of Turcoat 4178. Key to this speed is the manner in which the coating "sets" and becomes non-smearing immediately. Drying is unnecessary. Parts can be further processed *without any delay in production!* Moreover, the coating is *uniform*. There are no light, tell-tale untreated sections around welds, corners or holes.

The Turcoat 4178 Coating becomes non-smearing immediately upon withdrawal from processing. Drying is unnecessary. Parts can be handled freely while still wet without danger of smearing or streaking coating.

MEETS GOVERNMENT SPECIFICATION

Meets Government Specification MIL-C-5541.

EASY TO CONTROL

Simpler titrations... Great latitude in solution strength. Eliminates need for constant complicated control.

EASY TO USE

Apply by immersion, spray washer or hand methods. Gold color gives visual control over processing.

TURCO

FREE! Write for detailed technical literature.

Please affix coupon to company letterhead.
TURCO PRODUCTS, INC.
6135 S. Central Ave., Los Angeles 1, Calif.
Please send me detailed technical information on Turcoat 4178.

NAME_____

TITLE_____

TURCO PRODUCTS, INC.
Chemical Processing Compounds
6135 So. Central Ave., Los Angeles 1, Calif.
Factories: Newark, Chicago, Houston, Los Angeles
Offices in all Principal Cities

tive reaction, and again one which affects only certain types of chemical groups, is hydrolysis or reaction with water. Esters, amides and a few other chemical groups are subject to this reaction particularly in the presence of acid or alkali. The widely publicized sudden disintegration of nylon hosiery during certain smog conditions is an example; in this case, acid vapor in the smog is responsible for the hydrolysis of the polyamide (nylon).

Fatigue... What We Do and Don't Know About It

Abstracted from "Fatigue . . . What We Do and Don't Know About It," by George R. Gohm, Bell Telephone Laboratories, Inc., *SAE Journal*, Sept. 1955.

If a metallurgist tells you that fatigue is one of the most elusive and peculiar properties of metals, he has good reason for saying so. It has been studied more extensively than any other strength-of-materials problem. There is no precise correlation between fatigue and any of the other more readily determined properties. Despite the many theories of fatigue, no one has yet fully explained its behavior. Even laboratory fatigue tests don't give the complete picture of fatigue strength, and a factor of safety in design is a must.

Fatigue failures are probably due primarily to progressive strain hardening, particularly in areas of high stress concentration, but it has been suggested that the progressive strain hardening theory applies only to soft or unworked metals. For the cold worked metals, and by implication for the heat treated metals, the formation of fatigue cracks is associated with the semi-plastic condition developed by the action of alternate strains.

Many mechanical properties, including the fatigue characteristics of metals, have been determined and are available to the designer. Unfortunately, those properties which are usually determined in inspection are of little use to designers. For example, hardness cannot be used as a ready means of evaluating fatigue strength. Materials may have the same hardness, but widely different fatigue properties.

While it appears that the fatigue strength is somewhat related to the

(Continued on page 418)

Another example of **M-R-C** *Leadership —*

FOR 10 YEARS

the **M-R-C** *"Synthe-Seal"* bearing

has cut manufacturing and maintenance costs

Application of M-R-C *"Synthe-Seal"* Ball Bearings in electric motor. One of hundreds of applications in machine tools, coal mining machinery, home laundry equipment, hand tools, lawn mowers, water pumps, mixers and automobile wheels.

The M-R-C "Synthe-Seal" is a standard dimension ball bearing with removable synthetic rubber seals— KEEP LUBRICANT IN—KEEP DIRT OUT!

WRITE FOR FORM 1528

M-R-C Engineers are available for consultation on your bearing problems.

M-R-C Strom SRB GURNEY BALL BEARINGS

MARLIN ROCKWELL CORPORATION

Executive Offices: JAMESTOWN, NEW YORK

INDIANA
PERMANENT MAGNET
DESIGN INFORMATION

published for industrial and consumer product engineers and designers

HOW PERMANENT IS A PERMANENT MAGNET?

Permanent magnets *are* permanent. Proof of permanence is substantiated by many practical applications over long periods of years.

The continued accuracy of some of the most exacting scientific electrical measuring instruments, or of the familiar house-type, watt-hour meter depends upon a permanent magnet.

The speedometer in your car, the magneto in your power lawn mower, or your wife's magnetic knife rack in the kitchen may be consigned to the junk pile in time because of mechanical failure or obsolescence . . but definitely not because of magnetic failure.

There is a common belief . . which is incorrect . . that a permanent magnet supports its external magnetic field by dissipating some of its *internal* magnetic energy. This definitely is not the case.

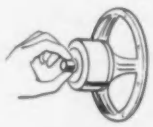
Adverse Factors on Remanent Magnetism. The magnetism of a permanent magnet can be adversely affected by any one, or a combination of, the following:

Elevated Temperatures can cause very appreciable initial losses in magnetism, up to complete demagnetization, even though metallurgical properties are not affected.

External Magnetic Fields from electro-coils, high electrical currents, or even other permanent magnets can partially or completely demagnetize the permanent magnet, and obviously, if the field is sufficiently strong, completely reverse the polarity.

Contact with Ferromagnetic Material by a permanent magnet in such a way that the normal internal field pattern is distorted can adversely affect the remanent magnetism. This is an important condition to avoid in the handling of magnetized magnets.

Changes in the Magnetic Circuit such as to produce a larger air gap than that on which it was initially magnetized, will reduce the strength of the magnet instantly and it is not recovered by reassembly to the original gap. A typical radio loud-speaker magnet, if removed from its associated steel circuit, then reassembled without remagnetizing, may lose as much as two thirds of its initial strength.



Vibration and Shock have little effect in most applications.

In all of these cases where only the remanent magnetism has been affected, losses can be recovered by remagnetization.

This article is a condensed version of a recently published feature article carrying the same title. Reprints of the full length article are available on request.

For assistance in designing the most efficient magnet for your product, consult our design engineers—without obligation, of course.

"CATTLE MAGNETS" PROTECT BOSSIE FROM STOMACH-ACHES: Cows often consume nails, staples and wire with their food. This causes a disorder called "hardware disease." To prevent it, you feed Bossie an Indiana "Cattle Magnet" (above). The magnet remains in her first stomach, gathering the stray metal. This keeps it from passing to her other stomachs (she has four, you know) where it can cause great distress.

New manual discusses selection of permanent magnet materials

This newly published, 12-page manual entitled, "Permanent Magnet Materials and Their Selection," discusses physical and magnetic characteristics and the applications of Cast Alnico Magnets (Grades I, II, III, IV, V, VI, XII); Sintered Magnets (Alnico II, IV, V, VI, Indalloy and Indox I); Ductile Magnets (Cunico and Cunife I) and Formed Magnets (Chromium and Cobalt).

Also included is a selector-type chart which lists magnetic characteristics, design factors, material characteristics, and manufacturing methods and limitations of the various magnetic materials. In addition, special sections present a "Glossary of Magnetic Terms" and a list of magnetic "Symbols."

Copies of this publication are available on request. Ask for Manual 5-C-4 on your company letterhead.

THE INDIANA STEEL PRODUCTS COMPANY
Valparaiso, Indiana
WORLD'S LARGEST MANUFACTURER OF PERMANENT MAGNETS

INDIANA PERMANENT MAGNETS

"FORD POWER helps cut our scrap handling time in half

The Ford Engine in our new Ross Carrier is ideal for our operation. It gives us tractor-like power for heavy-duty yard work and truck-like speed for fast highway hauling. Couldn't ask for a better engine."

—JOE E. BORG, President, Borg Compressed Steel Corp.
Tulsa, Oklahoma

Borg's Series 81 Ross Carrier, equipped with versatile Ford power, has 20,000 lb. capacity. Used as a prime mover, it's a one-man scrap collection system . . . self-loading, self-unloading and *self-dumping*. Borg, along with many other scrap and metal companies, has found that Ford-powered Ross Carriers cut handling time in half, *or more*—pay for themselves in a remarkably short time.

Because there's a Ford Industrial Engine to meet nearly *every* handling need, you too, can enjoy the lower operating costs that come with Ford Power. For Ford is the only industrial engine manufacturer to offer modern Short Stroke design in a *full line* of overhead-valve 4-, 6- and 8-cylinder gasoline engines. Short Stroke design cuts piston speed, shortens the piston stroke. This reduces friction and gives you more *usable* power on less fuel.

Add to this, rigid deep-block construction—plus a host of other exclusive durability features—and you know where Ford Engines get their ability to deliver peak performance longer—to stand up better in heavy-duty industrial work.

To better serve industrial power users, a network of newly appointed Ford Industrial Products Dealers has been set up across the nation. Now there's a Ford Industrial Power Headquarters in *your* area.

Ford
INDUSTRIAL ENGINES
AND POWER UNITS

Phone or write for complete information:
INDUSTRIAL ENGINE DEPT.
FORD Division of FORD MOTOR COMPANY
P. O. BOX 598, DEARBORN, MICH.

...at a lower cost per foot!

Now you can maintain highest quality standards at a lower cost wherever seamless aluminum tubing is used! Precision manufacturing produces closer tolerances that yield more footage per pound. This means important savings to you.

Combine this profitable economy with United's high quality, strict adherence to ordered specifications, ability to produce special orders (large or small) and fast delivery. Then you'll see why it's wise to specify and buy United . . . the quality name in Seamless Drawn Aluminum Tube.

Permanently United

UNITED WIRE
AND SUPPLY CORP.
PROVIDENCE 7, R. I. • OFFICES IN PRINCIPAL CITIES

LOOK TO UNITED FOR THE BEST IN ALUMINUM, COPPER AND BRASS TUBE AND WIRE

tensile strength of the material, it would be dangerous from a design standpoint to assume that the fatigue strength can be estimated from the tensile test.

Ductility values (elongation and reduction of area), frequently determined during the tensile test, cannot be used in design by the engineer to measure resistance to stress or strain. Yield strength is an arbitrary value based upon a given offset of the load-strain curve from the extension of the straightline portion of the curve, or upon a specified total elongation under load. Little work has been done to establish the relationship between the yield strength and fatigue. About all that can be said is that under conditions of completely reversed stress, the fatigue limit is, with few exceptions, considerably less than the yield strength.

The comparison of fatigue strength with the more readily determined mechanical properties of metals indicates that fatigue may not be evaluated except by independent tests upon the materials themselves.

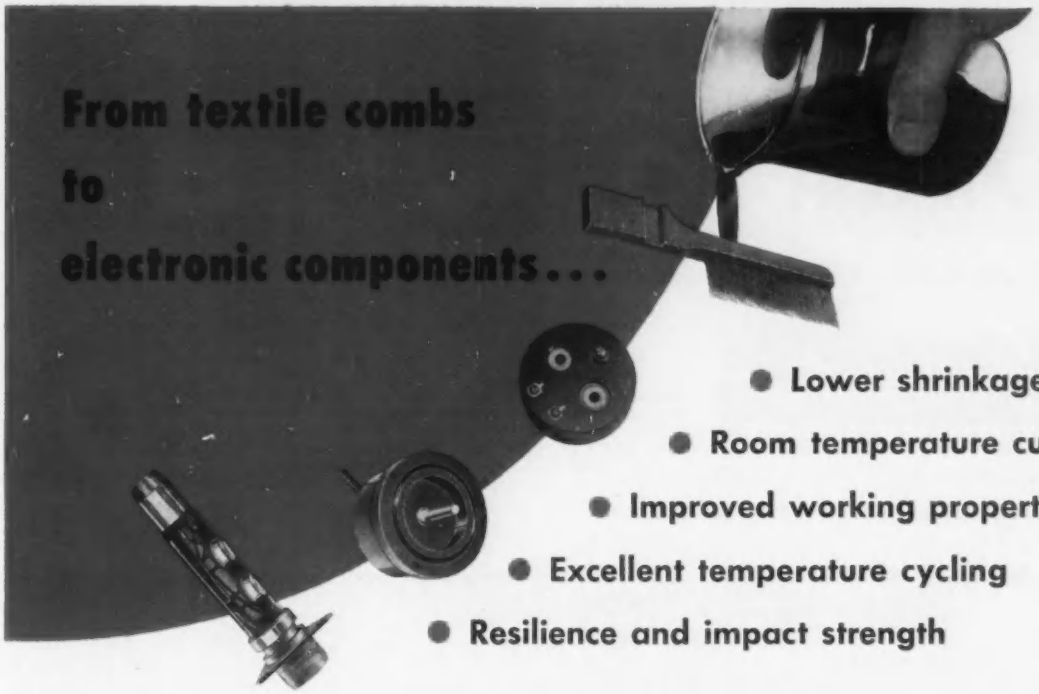
Some factors that are known to affect fatigue are as follows. Grain size, particularly the grain size in the ready-to-finish anneal, markedly affects fatigue. Higher values of fatigue are usually associated with small grain size material.

Work-hardening processes such as cold rolling, cold drawing and shot peening have all been used to increase the fatigue properties of metals. Since practically all fatigue failures originate at or near the surface, surface finish is bound to have an effect.

Large sections have been shown to have lower fatigue strengths. This may be attributed to variations in the streel throughout large sections. The type of machine used to determine the fatigue properties may likewise affect the results.

The effect of corrosion has been shown to be associated with the formation of corrosion pits. The result is similar to the notch sensitivity in uncorroded specimens.

The effect of mean stress on the stress range is of primary importance. Since stress conditions may vary, it is essential that the fatigue properties be established for various mean stresses. This means the determination of fatigue diagrams.



- Lower shrinkage
- Room temperature cures
- Improved working properties
- Excellent temperature cycling
- Resilience and impact strength

VERSATILE ELASTOMERIC ALLOYS

of *Thiokol*® Liquid Polymers and Liquid Epoxies

FILL COUNTLESS PRODUCT NEEDS

Check the five key properties listed above and see where elastomeric alloys of "Thiokol" liquid polymer and liquid epoxies fit into *your* product plans.

These new elastomeric alloys have already proved their value in plastic tooling, encapsulating, casting and sealing. While retaining all the basic advantages of the epoxy resins (high strength, chemical resistance, good electrical characteristics and excellent adhesion), they also provide unequalled resilience and impact strength. What's more, a wide range of important new properties can easily be developed by simply varying the ratio of "Thiokol" liquid polymer to epoxy resin.

Shown above are some typical applications for elastomeric alloys. The fact that they are used for encapsulating electronic and electrical components . . . for durable potentiometer components . . . and even for imbedding teeth in textile combs is proof enough of their amazing versatility. They also meet the exacting requirements of the plastic tooling, sealing and adhesive fields.

For complete information on the properties and potentialities of elastomeric "Thiokol" liquid polymer/epoxy resin alloys, write: THIOKOL CHEMICAL CORPORATION, 784 NORTH CLINTON AVE., TRENTON 7, N.J. In Canada: Naugatuck Chemicals Division, Dominion Rubber Company, Elmira, Ontario.

Thiokol®

PIONEER MANUFACTURERS OF SYNTHETIC RUBBER

Another Example of

VICKERS®

HYDRAULICS

in Automation

Ex-Cell-O Precision Cylinder Boring Machines shown below are finish-boring V-8 engine blocks. Like so many other high-production machines, these make generous use of hydraulics.

In addition to the advantages inherent in hydraulic control, Vickers Hydraulics gives you the benefits of a nation-wide company-operated field engineering and service organization to assure correct application and operation with least maintenance. Vickers has the complete line of hydraulic equipment necessary to take undivided system responsibility . . . to eliminate any risk of incompatibility of hydraulic components.

The Vickers Application Engineer near you will be glad to demonstrate the many benefits you can obtain by using Vickers Hydraulics. Write for a copy of Catalog 5002B.

VICKERS INCORPORATED

DIVISION OF SPERRY RAND CORPORATION

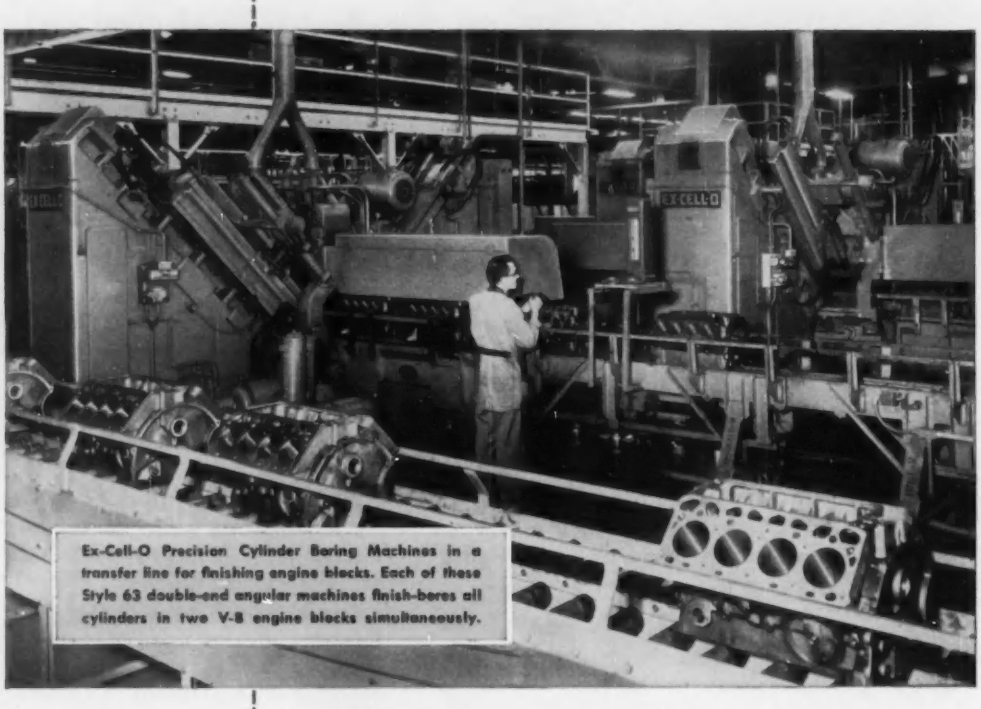
ADMINISTRATIVE and ENGINEERING CENTER

Department 1454 • Detroit 22, Mich.

Application Engineering Offices: • ATLANTA • CHICAGO • CINCINNATI • CLEVELAND DETROIT • HOUSTON • LOS ANGELES AREA (El Segundo) • MINNEAPOLIS • NEW YORK AREA (Summit, N.J.) • PHILADELPHIA AREA (Media) • PITTSBURGH AREA (Mt. Lebanon) • PORTLAND, ORE. • ROCHESTER • ROCKFORD • SAN FRANCISCO AREA (Berkeley) • SEATTLE • ST. LOUIS TULSA • WASHINGTON • WORCESTER

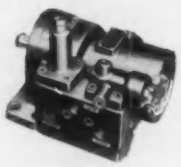
IN CANADA: Vickers-Sperry of Canada, Ltd., Toronto

Engineers and Builders of Oil Hydraulic Equipment Since 1921



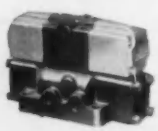
Ex-Cell-O Precision Cylinder Boring Machines in a transfer line for finishing engine blocks. Each of these Style 63 double-end angular machines finish-bores all cylinders in two V-8 engine blocks simultaneously.

Representative VICKERS® Units Used on Ex-Cell-O Precision Cylinder Boring Machines



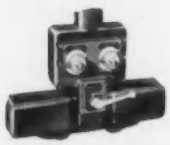
Two-Pressure Pump

Insures lower maintenance cost and saves horsepower and heat in two-pressure hydraulic circuit. Automatically provides high volume at low pressure and low volume at high pressure.



Solenoid Controlled Pilot Operated 4-Way Valve

Compact and versatile "sandwich" construction. Gasket mounting simplifies installation and overhaul . . . also minimizes piping.



Traverse and Feed Cycle Control Panel

Maintains smooth and constant preset feed rate regardless of fluctuations in cutting tool resistance or hydraulic pressure.

7350

UNICHROME
Trade Mark

News about
COATINGS for METALS
Metallic . . . . . Organic . . . . . Decorative . . . . . Protective

New improvement in Chromium Plate

Chemical-resistant coatings make durable product finishes

Finishes on a product today are exposed to a wider variety of chemical products than ever before. Service conditions are more severe. Chemical resistance in a finish has become of prime importance. Fortunately, designers have available coatings which can supply the proper chemical resistance.

Unichrome Plastisol Compounds combine the wide-range chemical inertness of vinyls with the pore-free, seamless and mechanical protection of a resilient, tough, thick film. They give also a satin-lustrous, rich finish.

PLASTISOLS NOW EASY TO APPLY

Unichrome Coating 5300 is *sprayable*, and builds a protective film up to 20 mils thick in one coat. For products of dippable size, Unichrome Series 4000 Plastisols are being used.

SYNTHETICS FOR SERVICE

With Unichrome Lacquers, Synthetics and Enamels, designers can specify the combination of properties needed to meet production as well as service requirements. Attractive yet durable finishing can be achieved on products exposed to heat, oils, chemical substances, outdoor exposure, moisture, caustics, acids and the like.

WHEN PROTECTION IS PRIMARY

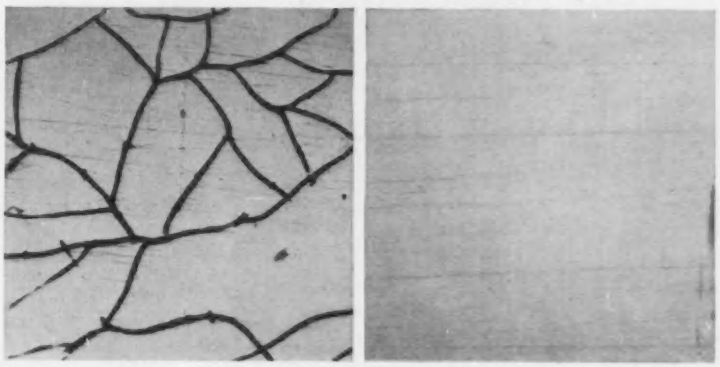
UCILON* Coating Systems were developed primarily for maintenance use, but are also used for product protection. The numerous coatings are of the vinyl, phenolic, fish oil, neoprene, Thiokol and chlorinated rubber types.

Send for Bulletins Chem-C-1 and PF-1 which give more data. **Trade Mark*

METAL & THERMIT
CORPORATION

100 East 42nd Street, New York 17, N. Y.
Pittsburgh • Atlanta • Detroit
East Chicago • Los Angeles
In Canada: Metal & Thermit-United Chromium of Canada, Limited, Toronto 1, Ont.

Crack-Free Chromium Deposits give unique protection to parts



(Left) Surface view of etched ordinary chromium surface, enlarged about 75X, shows typical network of cracks. (Right) Etched Crack-Free Chromium surface shows none of this. Steel parts are therefore securely protected from rust.

Electrodeposits become continuous surfaces as thickness increases and porosity vanishes . . . except for *ordinary* chromium plate. Something else happens. Cracks develop as the chromium deposit builds up. Through these defects, corrosives reach the underlying metal. Unichrome Crack-Free Chromium eliminates these structural imperfections.

Comparative tests have demonstrated that Crack-Free Chromium makes a tremendous difference in corrosion protection.

At 110° F, and 100% relative humidity, only .0003" of Unichrome Crack-Free Chromium protected steel from rust for over 1000 hours. With ordinary chromium, identical parts were rust-covered in just *days*. In testing protection of .0005" of chromium plate in salt spray for 100 hours, one user found steel shafts protected with Crack-Free Chromium unaffected; while shafts with ordinary chromium were enveloped with rust.

WHERE TO USE

That is a question best answered by product designers. Knowledge of the complete advantages may suggest many uses. Crack-Free Chromium also offers:

1. Wear-resistance, hardness, and low friction.
2. Improved non-galling, non-seizing properties.
3. A more ductile deposit, resistance to thermal shock and better protection at elevated temperatures. Good impact resistance.
4. Excellent leveling action which helps cover surface imperfections. Also easier, faster grinding, if required.
5. Protecting the base metal without undercoats, Crack-Free Chromium can be used directly on steel or zinc base die castings for many applications.

APPEARANCE

A satin, matte finish, Crack-Free Chromium can be left as is, or readily buffed to high luster. Ask for recommendations, or send for Bulletin CFC-1.

Big machine volume and speed in this compact new

PRINTMASTER 810

Sturdy, compact, smartly styled, the new medium-priced Printmaster 810 has *everything*—easy, low-cost operation, high speed and *big machine* production capacity.

It prints and develops in one continuous operation at speeds up to 40 feet per minute . . . easily handles roll or cut stock as wide as 42 inches. Easy-to-reach controls command quick response throughout the machine's entire operation. Developing and printing sections are automatically synchronized for simplest operation at any speed.

Complete diffusion of vapors through exclusive "jet-nozzle feed" insures uniform, dry, fully developed prints. Spacious receiving trays automatically stack prints in sequence. Electrically welded one-piece assembly stands 61″ high, 61″ wide, 42″ deep (including feedboard).

See and try the Printmaster 810 yourself. Call your nearest Ozalid distributor for a demonstration. His number's in the phone book, or write Ozalid, Dept. 0-4, Johnson City, N. Y., for descriptive brochure.

OZALID®
DIRECT COPY COPY SYSTEMS

A Division of General Aniline and Film Corporation
In Canada, Hughes Owens Co., Ltd., Montreal

LOOK FOR IT!

Got A Printmaking Problem? Call your local Ozalid representative. His expert advice is yours for the asking—whether or not you now own or plan to buy Ozalid equipment.

Strataflo

ALL POSITION
Check Valves
WITH THE FAMOUS
FLEXIBLE METAL POPPET
CAN'T LEAK • CAN'T STICK

For rugged service . . . cold or hot water or steam. Sensitive. 200 lbs. pressure. Also available with Noiseless Rubber Poppet. Seven sizes. Write today for Bulletin 201.
Order from your jobber.
STRATAFLO PRODUCTS, INC.
FORT WAYNE, INDIANA

Molded
BLACK NYLON SCREWS and NUTS

Insulate and fasten without bushings, washers, etc.
In stock 6-32, 8-32, 10-32

NyGrip BLACK NYLON Cable Clips

Light-weight non-conducting support for wiring, tubing, etc.
In stock ⅛" to 1½" dia.
Free Samples . . . Write
WECKESSER CO.
5265 N. Avondale Avenue • Chicago 30, Illinois

NEW BOOKS

Electron and Nuclear Counters

SERGE A. KORFF, *A.B., M.A., and Ph.D, New York University.* 3¾ x 5¾ *in., 363 pp. Published by D. Van Nostrand Company, Inc., 250 Fourth Ave, New York 3, N. Y.* $6.75.

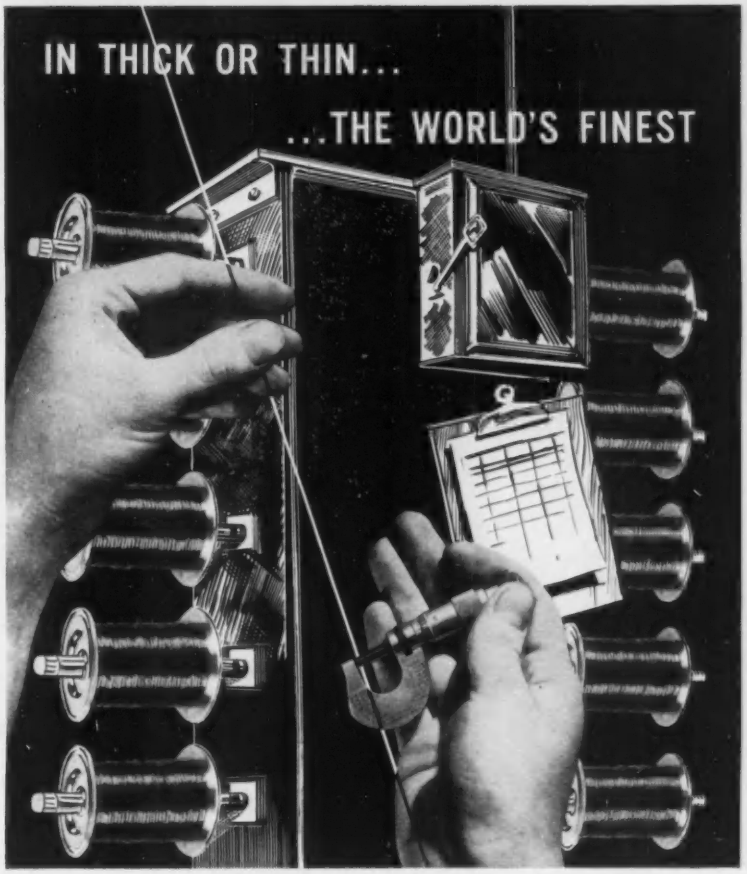
In this new second edition, emphasis is placed on growing usefulness of counters in many phases of scientific and industrial work. The expanded material includes detailed information on gas-discharged phenomena together with many references to the general field of counters. The most important addition to the book is a new chapter on Scintillation Counters. Older and more obsolete chapters have been deleted; many more tables, diagrams and more complete bibliography have been added to make this the most complete collection of data on counters available. Numerical examples illustrating each main point, and problems and answers at the end of each chapter act as a guide for the reader.

Generalized Thermodynamic Properties of Pure Fluids

AKSEL L. LYDERSEN, ROBERT A. GREENKORN and OLAF A. HOUGEN, *Chemical Engineering Dept., University of Wisconsin.* 8½ x 11 *in., 99 pp, published by Engineering Experiment Station, College of Engineering, University of Wisconsin, Madison 6, Wis.* $3.50.

Generalized methods for estimating thermodynamic properties of pure fluids based upon the theorem of corresponding states are commonly used where reliable experimental data or accurate equations of state for specific fluids are not available. These methods are satisfactory for purposes of process design where extreme accuracy is not required, for purposes of making rapid preliminary estimates before employing precise equations of state and for purposes of planning experimental work in establishing pvT data. Generalized methods are particularly ex-

(Continued on page 425)



TEFLON* INSULATED WIRE AND CABLE

The name Hitemp Wires, Inc. on a spool of Teflon insulated wire, tubing, multi-conductor cable, lacing cord or tape . . . is your assurance of highest quality — born of years of experience and development, and modern craftsmanship.

Although Teflon is as thin or thinner than ordinary insulations it has the amazing working temperature range of −90 C. to +250 C. . . . it has opened new horizons in the electrical and electronic industries.

Hitemp's Teflon insulated products offer: low loss factor, low dielectric constant, high volume resistivity, non-flammable, low coefficient of friction, unaffected by moisture, tough . . . yet flexible, completely inert to all known commercial solvents.

For better products . . . for lower production costs . . . for improved performance, call the leading specialist in high temperature insulations today . . . your nearest Hitemp Wires, Inc. representative or sales engineer.

HITEMP WIRES, INC.
26 WINDSOR AVE., MINEOLA, NEW YORK

NATIONAL REPRESENTATIVES

WASHINGTON, D.C. GOVERNMENT
John W. Houston Jr
1825 "K" Street, N.W.
Washington 6, D.C.

N. Y. & N. J.
Rar Distributors
240 Old Country Rd.
Hicksville, N. Y.

CANADA, VIRGINIA, W. VIRGINIA, PENNSYLVANIA
Aironic Accessory Co
161 Orinoco Drive
Brightwaters, N. Y.

KENTUCKY & OHIO
Gallagher Company
15 Ritchie Ave.
Cincinnati, Ohio

TEXAS
General Power Equip.
5626 Dyer Street
Dallas 6, Texas

N. C., S. C., & TENN.
Glenn & Larson
123 Brevard Court
Charlotte 1, N. C.

MD. & DEL.
Sol. W. Goodman
32 W. Biddle St.
Baltimore 1, Md.

MICHIGAN
James B. Morrow
85 Louise Ave.
Highland Park, Mich.

INDIANA
Richard C. Warner
Box 338
South Whitley, Ind.

ILL. & WIS.
Wesley L. Wilson
2750 W. North Ave.
Chicago, Ill.

FLORIDA
Larry Johnson
8163 N. E. 2nd Ave.
Miami, Florida

ARK., KAN., MO., NEB.
White Supply Co.
4343 Duncan Ave.
St. Louis, Mo.

NEW ENGLAND
Richard Whitehead
Guilford, Conn.

IOWA
Caine Sales Agency
3020 N. Cicero Ave.
Chicago 41, Ill.

SAN FRANCISCO
Bill Kolans & Co.
3589 20th Street
San Francisco, Cal.

LOS ANGELES AND CENTRAL CALIF.
C. B. Rush
& Associates
3757 Wilshire Blvd.
Los Angeles 5, Calif.

S. CALIF. & ARIZ.
Fred W. Falck Co.
110 W. Broadway,
Rm. 404
Glendale 4, Calif.

UPPER N. Y. STATE
Philip L. Kirsh
223 Windemere Road
Rochester 10, N. Y.

EXPORT
Hitemp Wires, Inc.
Export Division
Mineola, N. Y.

OREGON & WASH.
Ray Johnston Co.
11009 Evanston Ave.
Seattle, Wash.

TULSA, OKLA.
Joseph Turner
P. O. Box 7068
Tulsa, Okla.

BIRMINGHAM, ALA.
C. H. Emory
P. O. Box 9013
Birmingham 9, Ala.

*DuPont's Trade Name for POLYTETRAFLUOROETHYLENE

SAVE MONEY!

get
better service
on

Vibration dampeners and snubbers

•

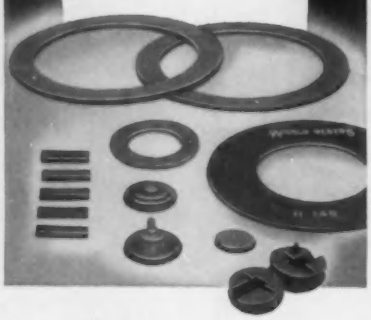
Molded parts

•

Clutch facings

•

Molded friction parts



let
WORLD BESTOS
serve you!

World Bestos offers you more than 30 years' engineering and manufacturing experience. Chances are our immense resources and facilities can supply you with molded parts and friction components—to meet your requirements—at a savings in both time and money.

● **Send your blueprints (or samples) for prices and delivery information to WORLD BESTOS, Industrial Products Section, New Castle, Ind., Phone: 2360.**

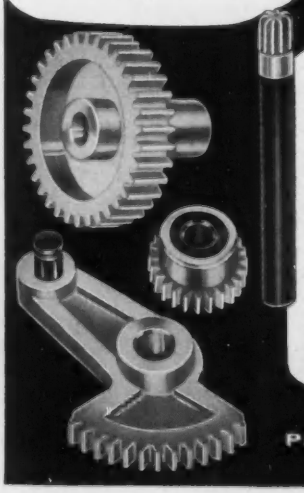
WORLD BESTOS
NEW CASTLE, INDIANA
DIVISION OF THE
Firestone
TIRE & RUBBER CO.

YOUR COMPETITOR'S EYE will be quick to see profitable new plastics applications at the NATIONAL PLASTICS EXPOSITION. New materials, new uses, new equipment—to see and feel. All that's new in plastics at New York, June 11-15. Special conferences, too. Don't *you* miss it. Write for tickets today. On your company letterhead, please. Sorry, not open to general public.

Plastics **shaping tomorrow's products**

at the new New York Coliseum
7th National Plastics Exposition sponsored by:
The Society of the Plastics Industry, Inc., 67 W. 44th Street, New York, N. Y.

NOW!
new economies in NYLON GEARS
means savings in gear costs up to 90%



Our many years of pioneering and successful production of Nylon Gears, plus new reduced mold charges, can now make even greater economies for you in the use of Nylon Gears. With the great variety in molds now possible, Nylon should not only be considered as an economy measure but the answer to many problems where a compact design is necessary. Nylon Gears are quiet, durable, efficient and need less lubrication – they mate perfectly with metal gears.

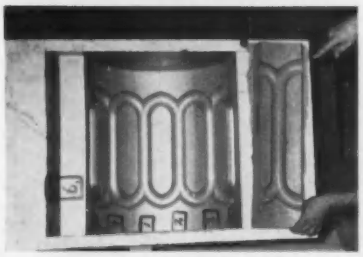
Let our engineers with more than a decade in gear experience show you how Nylon Gears can save you money – let us consider your gear problems during the design process—send blueprints or specs for prompt estimates.

103

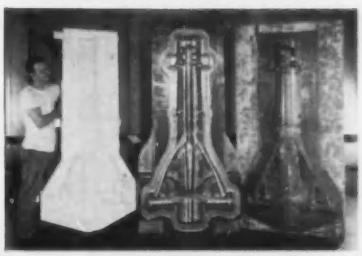
PG **PROCESS GEAR CO., INC.**
4602 W. Fullerton • Chicago 39, Illinois

HYSOL
Plastic Tooling Materials . . .
• Cut Costs
• Save Time
in these applications

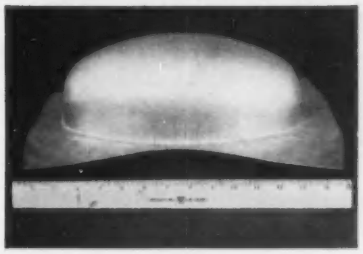
• CORE BOXES •



• KELLER PATTERNS •



• DIE FORMED PART •



HYSOL

• Write for details •

HOUGHTON LABORATORIES INC.

150 HOUGHTON AVE.
OLEAN, NEW YORK
In Canada
HYSOL (CANADA), LTD.
184 Laird Drive
Leaside, Toronto 17, Ontario

cellent for purposes of instruction in elementary thermodynamics courses, since principles may be taught thereby without spending time in tedious calculations.

This investigation is intended to extend the generalizations of previous investigators to include the experimental data of compounds for which considerable pvT data are available, and to present the data in extensive tables for convenient use.

Tables include: Compounds used for generalized correlations of pvT data; bibliography on pvT data, thermodynamic properties of saturated liquids and gases, compressibility factors of pure gases and liquids; reduced densities of pure gases and liquids; reduced densities of saturated liquids, enthalpy deviations of gases and liquids from ideal gas behavior; fugacity coefficients of pure gases and liquids; vaporization equilibrium constants, enthalpy deviations of pure gases and liquids from ideal gas behavior; internal energy deviation of pure gases and liquids and reduced vapor pressure comparison of experimental and generalized values.

Design of Piping Systems

M. W. Kellogg Co. 8½ x 11 *in.*, 365 *pp. Published by John Wiley & Sons, Inc.*, 440 *Fourth Ave., New York* 16, *N. Y.* $15.

The objective of this second edition is to supplement code rules and other readily available information with specific mechanical design approaches for entire piping systems as well as their individual components and to provide background information which will engender understanding, competent application of analytical results, and the exercise of good judgment in handling the many special situations which must be faced on critical piping. In line with this objective, the opening chapter presents a condensed treatise on the physics of materials. It is followed by a comprehensive study of the capacity of piping to carry various prescribed loadings. The utilization of materials is then considered, not only in relation to fundamental knowledge but also on the basis of conventionally accepted practices.

The present edition also includes a greatly augmented treatment of local

(Continued on page 427)

SERVOSPEED
MOTOR CONTROLS

- DIGITAL CONTROL
- ANALOG CONTROL
- SYNCHRONIZING
- SEQUENCE CONTROL
- VARIABLE SPEED

Write or call for further data

Servospeed
DIV. of ELECTRO DEVICES, Inc.
4 Godwin Ave., Paterson, N. J.
ARmory 4-8989

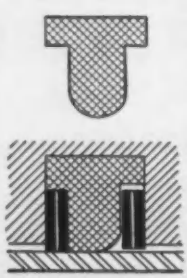
"Operation Redesign"
AT YOUR COMPANY, TOO?

Recruit PALMETTO G-T® RING!

If your company is concentrating on the economical redesign of current products to meet the increased competition of "post-Korea", you'll be interested in what others have found. In designing for less costly, just-as-effective substitutes for Vee, Cup and Flange packings, many design engineers have turned to the G-T Ring. They have found that, as a dynamic pressure seal (from 0 to 20,000 psi) for rod or piston applications, Palmetto G-T Ring can't be matched—for economy . . . for effectiveness! Here are some of its successful applications:

HYDRAULIC VALVES • HYDRAULIC PUMPS • HYDRAULIC PRESSES • COMPRESSION TESTING MACHINES • DIE CASTING MACHINES • PIPE TESTING MACHINES • POWER STEERING SYSTEMS • HYDRAULIC BRAKES • LIFT TRUCKS • ARBOR PRESSES • RESISTANCE WELDER HOLDERS • MATERIALS HANDLING EQUIPMENT • HYDRAULIC AND PNEUMATIC CYLINDERS • PORTABLE LIFTING DEVICES • ACCUMULATORS • AUTOMATIC FEED TABLES • WIRECRIMPERS • SERVO CONTROL VALVES • HYDRAULIC TABLES • HYDRAULIC MOTORS •

THE GIST OF THE G-T RING



CANNOT SPIRAL...

The Palmetto G-T Ring, unlike an "O"-Ring, will not twist and turn in the groove. The "T"-form prevents spiral failure in dynamic applications.

CANNOT EXTRUDE...

Resilient "T"-section supported by non-extrusion rings on either side *makes extrusion impossible.* As pressure is applied non-extrusion rings are urged against wall, blocking path of extrusion.

Discover how "extrusion-and-spiral-proof" G-T Ring can improve your cost picture in the design or redesign of your products. Write for our Bulletin MP-200, or consult Greene, Tweed's engineering department.

PALMETTO Packings

packing more performance into every application

GREENE, TWEED & CO. North Wales, Pa.

USE ROTO-GLO® Quiet Switch

AT FULL CURRENT RATING ON *FLUORESCENT LOADS*

On any A.C. circuit, ROTO-GLO Switches can be used to full current rating on incandescent and fluorescent lighting loads, and on electric motors to 80% of current rating.

Inside the totally enclosed plastic body are large silver alloy contacts that will not oxidize under continuous heavy duty service. Screwless terminals make for fast, efficient wiring. ROTO-GLO Switches glow in the dark, turn off and on like a radio or television, and are quiet.

Available in P&S Despard (15 Amp., 120 Volts A.C., 277 Volts A.C.) or conventional strap type (15 Amp., 120 Volts A.C.). Approved by Underwriters' Laboratories, Inc.

Write today for complete information to Dept. PE-4

Strap Type

Despard

P&S

PASS & SEYMOUR, Inc.

Syracuse 9, N. Y.
71 Murray St., New York 7, N. Y
1229 W. Washington Blvd., Chicago 7, Ill.

WHEELS WHEELS WHEELS

for Products That Roll!

Be SURE With —

ALLIED Rubber Tired, Metal Disc Wheels; All Sizes & Kinds!

CONSULT ALLIED ON ALL YOUR SMALL WHEEL NEEDS!

• Build quality—lasting service—sales appeal — customer satisfaction into your product with ALLIED Wheels! Big range of stock sizes and types — or produced to your precise specifications. Priced "right"; with dependable delivery to meet your production schedules

ALLIED Wheels....
PRECISION MADE TO YOUR SPECIFICATIONS!

WRITE TODAY!

ALLIED WHEEL PRODUCTS, INC.

27 BROADWAY • TOLEDO 4, OHIO

Representatives And Warehouses In Principal Cities

flexibility and stress intensification, and a chapter on simplified methods of flexibility analysis contains several newly developed approaches which should prove helpful for general assessment of average piping, or in the planning stage of the design of critical piping. The Kellogg General Analytical Method, now extended to include all forms of loading, has been improved in presentation by the use of numerous sample calculations to illustrate application procedures, and by placing the derivations of the formulas in an appendix. Included in this edition are chapters on expansion joints and on pipe supports that offer, it is believed, the first broad treatment of these items with regard to critical piping. The rising significance of vibration, both structural and fluid, is recognized in the final chapter, which was also prepared especially for this edition. For ready accessibility of information, the charts and tables most frequently needed for reference have been grouped at the end of the text, and a detailed subject index has been provided.

Ultrasonic Engineering

ALAN E. CRAWFORD, 5¾ x 8¾ *in.*, 344 *pp. Published by Academic Press, Inc., 125 E. 23 St., New York, N. Y.* $8.

With the advent of magnetostrictive materials as sources of ultrasonic energy, work on the effects and uses of high intensity vibratory waves increased rapidly. Literature on both theoretical and applied aspects is now considerable. The object of this book is to collect and correlate the mass of data available on the effects and applications of ultrasonic waves and to treat in detail basic methods of generation.

In the past, ultrasonics was considered to lie mainly in the field of the physicist, but now that numerous applications of ultrasonic processes have become firmly established, it has entered the province of the engineer, for whom this book has been written. Thorough knowledge of the underlying basic theory which the book supplies is essential to the successful application of the method, while the practical applications discussed are based on the author's work during his

(Continued on page 429)

Do you need brake blocks to stop a 600 horsepower oil drilling drawworks . . . *or* small friction units to control the cycles of an automatic washer?

Thermoid is the ideal source for these and many other *friction* and *rubber* components. For 75 years Thermoid has satisfied the varied and specific requirements of design engineers for high quality, long wearing, trouble-free Hose, V-Belts, Friction Materials and Molded Rubber Parts.

Thermoid multi-plant facilities are big enough to handle your largest mass production demands . . . small enough to make *personalized engineering* service more than just a phrase.

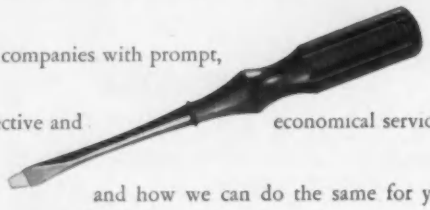
Talk over your projects or problems with our engineers at the DESIGN ENGINEERING SHOW, Booth #1023—May 14-17.

Thermoid

Thermoid Company
Trenton, New Jersey

You can profit from Tyer's extensive technical knowledge and vast experience with molded rubber problems.

Call in a Tyer Field Engineer. He can show you how Tyer has helped other companies with prompt, effective and economical service . . . and how we can do the same for you.



Tyer Rubber Company

1856 TYER 1956

ANDOVER, MASSACHUSETTS, U. S. A.

PE-4

TYER RUBBER COMPANY
Industrial Division, Dept. 95, Andover, Massachusetts
Gentlemen:

☐ Please send me the new *Tyer Rubber Engineering Brochure* including technical specifications and relative properties of natural and synthetic rubbers.

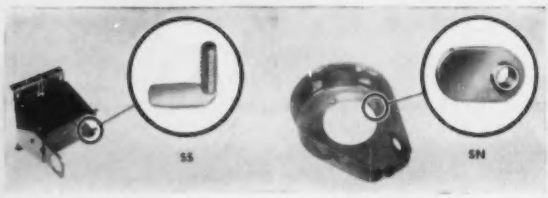
☐ Please have Tyer field engineer call on _____ (date). No obligation, of course.

NAME _____

FIRM _____

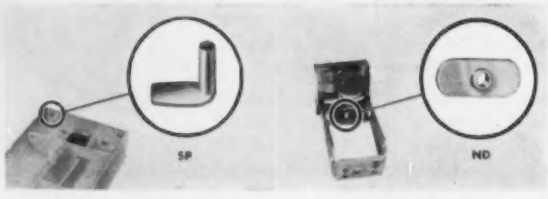
STREET _____

CITY _____ ZONE _____ STATE _____



Ohio SS Weld Screw in drill stand

Ohio SN Weld Nut in motor housing



Ohio SP Weld Pin in flourescent fixture

Ohio ND Weld Nut in swivel chair assembly

OHIO SPOTWELD FASTENERS

CAN HELP YOU—

SPEED UP PRODUCTION

Primary fasteners, pre-attached firmly in place, permit faster, trouble-free final assembly. OHIO Spotweld Nuts with pilot for easy locating permit rapid positioning without jigs or fixtures.

ELIMINATE COSTLY DRILLING AND TAPPING OPERATIONS

By pre-attaching OHIO SN and ND Nuts you eliminate the need for tapping holes in components and permit change from expensive castings to stampings.

REDUCE WEIGHT—INCREASE STRENGTH

In the motor housing shown above the change from casting to stamping reduced component weight over 50%, yet actually increased product strength.

IMPROVE PRODUCT APPEARANCE

OHIO Spotweld Pins and Screws permit easy assembly with no protruding fasteners to mar outside appearance.

USE FEWER PARTS

A single OHIO part frequently replaces two or more other parts.

MAKE BETTER USE OF YOUR PRESENT WELDING EQUIPMENT

OHIO Spotweld Parts can be attached using the same welding set-up used in fabricating your assemblies.

SAMPLES AND INFORMATION AVAILABLE ON REQUEST

Specialists in the Manufacture of Weld Fasteners and Adjusting Screws

THE OHIO NUT AND BOLT COMPANY

41 First Avenue — Berea, Ohio

association with the research and development team at Mullard Research Laboratories and an exhaustive survey of current British and American practice.

Engineering Drawing and Geometry

RANDOLPH P. HOELSCHER, *Professor, and Clifford H. Springer, Professor, University of Illinois.* 8½ x 11¼ *in., approx. 263 pp. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y.* $8.

Based on the organization and methods of a previous volume prepared by Harvey H. Jordan and the senior author, this large-size book is intended primarily as a text for courses in drafting for engineers. Throughout, the emphasis has been placed on the engineers' needs rather than those of the draftsman. Classical drawing technique and symbology is used throughout. Little effort is made to recommend the newer simplified drafting methods which might only serve to confuse the student.

Separate chapters on fasteners, drawing for interchangeable assembly, intersections and developments, charts and diagrams, map drawing, pipe drawing, machine drawing, tool drawing and welding drawing are included.

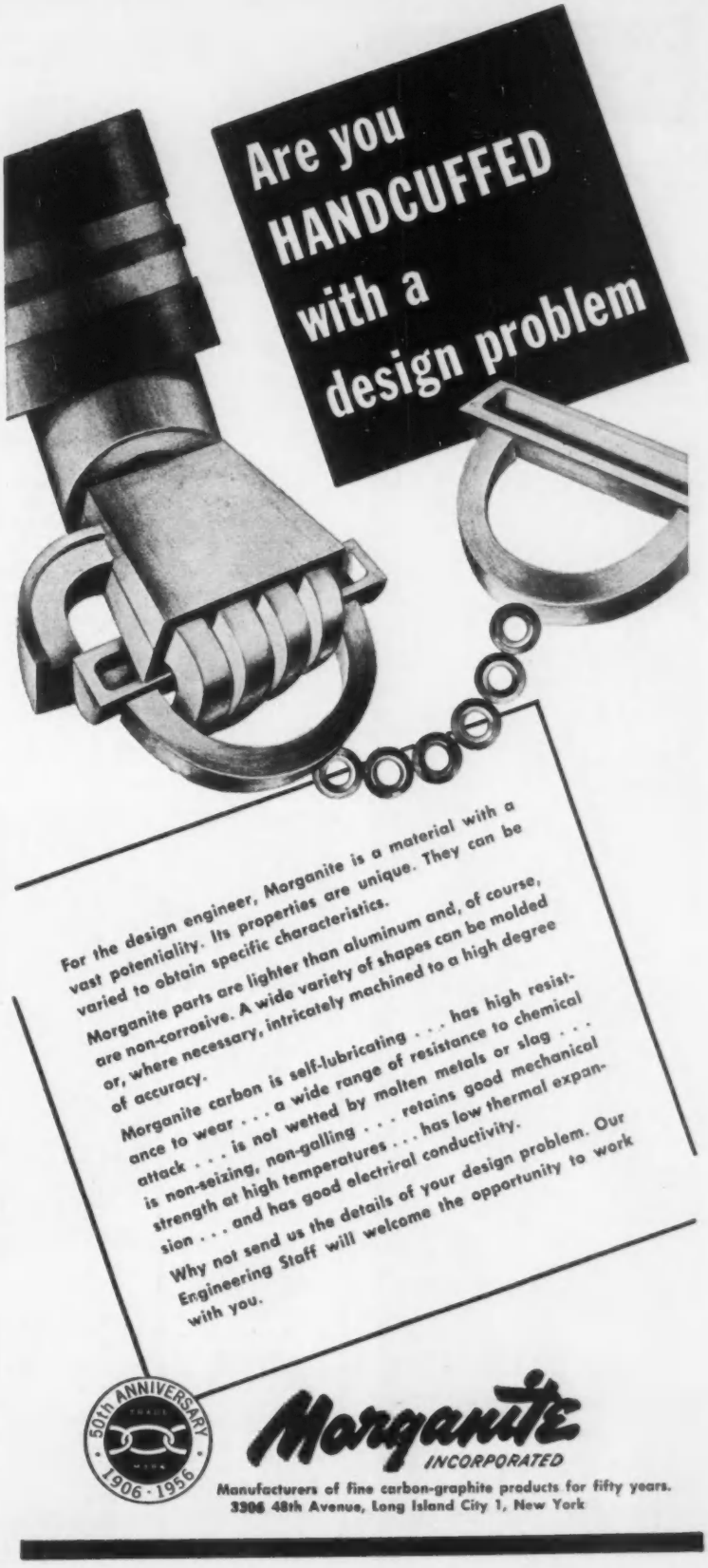
Temperature— Its Measurement and Control In Science and Industry

American Institute of Physics. 6¼ x 9¼ *in., 467 pp. Published by Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y.* $12.

Contained in this reference book are the proceedings of the Third International Symposium on Temperature, sponsored by the American Institute of Physics, the National Bureau of Standards and the Office of Ordnance Research, U.S. Army.

Twenty-four papers, each prepared by one or more experts from this country and abroad, cover significant new developments in the techniques of determining temperatures over the entire range from 0.001 K to the core of an atomic explosion. Among these important developments are: details

(Continued on page 431)


Are you
HANDCUFFED
with a
design problem
For the design engineer, Morganite is a material with a vast potentiality. Its properties are unique. They can be varied to obtain specific characteristics.
Morganite parts are lighter than aluminum and, of course, are non-corrosive. A wide variety of shapes can be molded or, where necessary, intricately machined to a high degree of accuracy.
Morganite carbon is self-lubricating . . . has high resistance to wear . . . a wide range of resistance to chemical attack . . . is not wetted by molten metals or slag . . . is non-seizing, non-galling . . . retains good mechanical strength at high temperatures . . . has low thermal expansion . . . and has good electrical conductivity.
Why not send us the details of your design problem. Our Engineering Staff will welcome the opportunity to work with you.
50th ANNIVERSARY
1906 · 1956
Morganite
INCORPORATED
Manufacturers of fine carbon-graphite products for fifty years.
3306 48th Avenue, Long Island City 1, New York

FILL OUT COUPON
FOR FACTS, SAMPLES!

ALUMINUM COMPANY
OF AMERICA
2247-D Alcoa Bldg., Pittsburgh 19, Pa.
Gentlemen:
Please send complete specification data and samples of your aluminum fasteners.

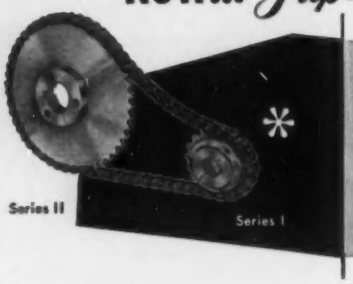
Name _____
Title _____
Company _____
Address _____

Always fasten aluminum with **ALCOA®** Aluminum Fasteners

available at your local ALCOA distributor

ALCOA ALUMINUM FASTENERS

NOW... *Grip-Master®* SPROCKETS have



HARDENED TEETH* up to 7" in diameter at no extra cost

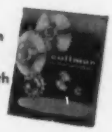
- **More resistance to shock loads and abrasion**
- **Lower operating costs**
- **This means: *longer chain drive life "on-the-shaft!"***

Grip-Master Sprockets are stocked in consecutive tooth sizes. Bores in 1-16" increments. Standard keyways and set screws are included. This means that exact speed ratios and bore sizes are available "off the shelf." No remachining needed. No lost time.

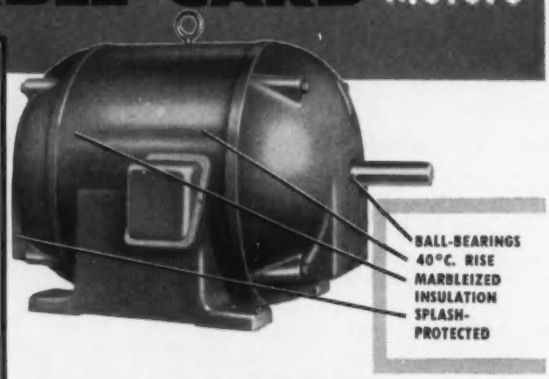
What's more, re-usable hubs and bushings keep your replacement costs way down. For better, lower-cost chain drive operation on your equipment, take advantage of these features now.

cullman
POWER TRANSMISSION ROLLER CHAINS AND SPROCKETS
CULLMAN WHEEL COMPANY
1334 ALTGELD ST. • CHICAGO 14, ILL.

Write today for the first really engineered approach to the problem of supplying custom sprockets "off the shelf." Your Cullman Grip-Master catalog is complete with sizes, illustrations and price lists. Ask for Bulletin No. 200.



Get the facts on
MARBLE-CARD *motors*



1/6 to 125 HORSEPOWER
All Marble-Card STANDARD motors have these wanted features — all are available with both old and new NEMA frames *at same price.*

ASK FOR NEW CATALOG 55-1

CHARTER NEMA MEMBER

MARBLE-CARD ELECTRIC CORPORATION
GLADSTONE, MICHIGAN
AFFILIATED WITH MARBLE-ARMS CORPORATION

of the 1954 revision of the international temperature scale; new determinations of thermometric fixed points; revisions of the magnetic temperature scale at very low temperatures; the use of superconductors and semiconductors for temperature measurement; discussions of partial temperatures and limitations of temperature concept in non-equilibrium situations; optical methods of temperature measurement; temperature measurements in engineering.

Specifications for Steel Piping

6 x 9 in., 432 pp, heavy paper cover. Published by American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. $4.

The 1955 edition of this compilation sponsored by ASTM Committee A-1 on Steel contains the latest approved form of 58 specifications for ferrous pipe, tubes, castings, fittings and bolting materials.

Included in these standards, 47 of which have been revised this year, are Tentative Methods and Definitions for Mechanical Testing of Steel Products, and Classification of Austenite Grain Size in Steels. Also included in the compilation are American Standards for Wrought Steel and Wrought Iron Pipe (B 36.10) and Stainless Steel Pipe (B 36.19).

Cast-Brass Solder-Joint Drainage Fittings

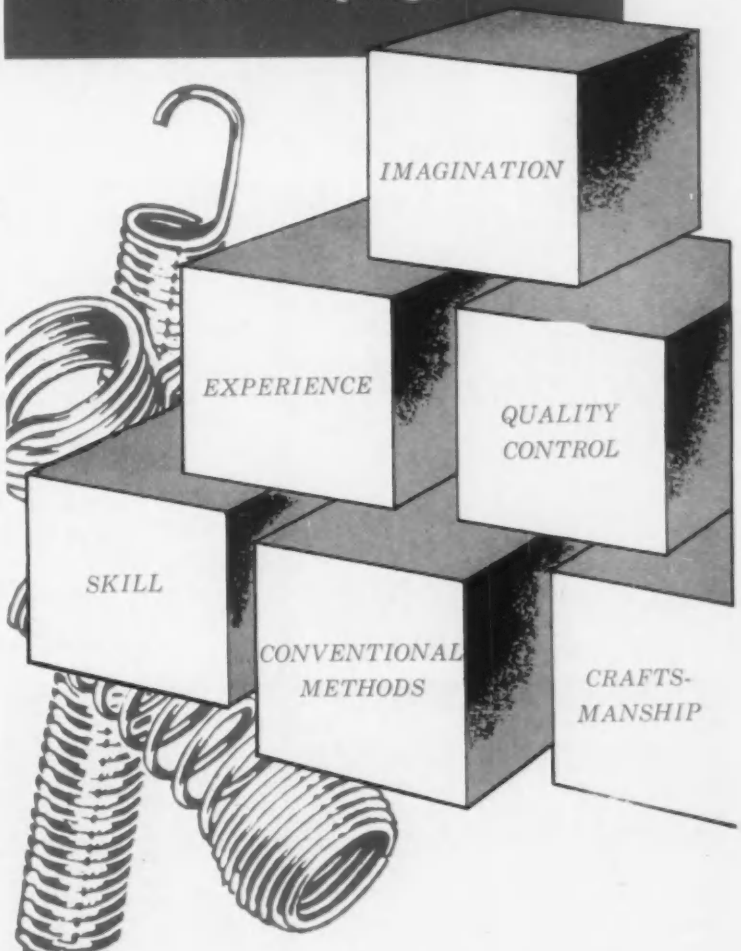
8½ x 11 in., 21 pp, paper bound. Published by American Society of Mechanical Engineers, 29 W. 39 St., New York 18, N. Y. $1.25.

In addition to the appointed members of the task group, all firms known to be manufacturing, or contemplating the manufacture of, fittings of the type covered in this standard were invited to have representatives participate in the work. The invitation included three Canadian manufacturers. Seven meetings of the group were held. Nine drafts of the proposed standard were made before complete agreement was reached.

In the development of this standard every attempt was made to avoid

(Continued on page 433)

BUILDING BLOCKS
for Accurate Springs

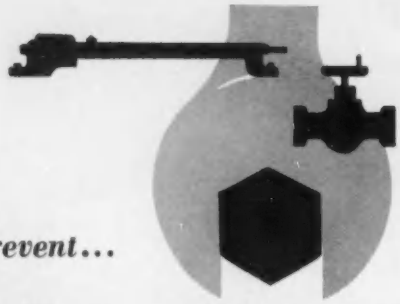


Conventional, accepted standards of manufacturing springs are a building block at Accurate Springs. So are skill, craftsmanship, experience, quality control—*and imagination!* It all adds up to a better spring, at lower cost, held to closer tolerances—*for YOU.*

Accurate Springs

ACCURATE SPRING MFG. CO.
3815 West Lake Street
Chicago 24, Illinois

SPRINGS • WIREFORMS • STAMPINGS



Prevent...

Galling and Seizing

Use

Electrofilm™

U.S. PAT. NOS. 2,700,623 - 2,703,768

4396

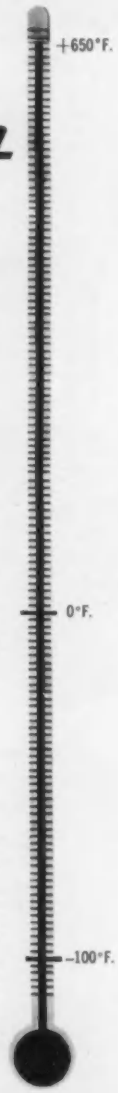
SOLID FILM LUBRICANT

on TITANIUM
on STAINLESS
on ALUMINUM

Electrofilm 4396 prevents galling and seizing of all mating surfaces . . . even when SIMILAR METALS ARE USED . . . whether they be Titanium, Stainless or Aluminum.

The Coefficient of Friction of Electrofilm coated Titanium is .032 at approx. 80,000 psi.

Positive lubrication from —100°F. to +650 F.



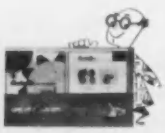
Electrofilm

works where other lubricants fail

Prevents . . . **GALLING AND SEIZING**
EXCESSIVE WEAR

Lubricates under conditions of . . . **EXTREME HEAT**
EXCESSIVE COLD
INACCESSIBILITY
HIGH SPEEDS
HIGH LOADS

Inhibits . . . **FRETTING CORROSION**



FREE! for your files

Complete FILE FOLDER containing CASE HISTORIES and TECHNICAL DATA on the numerous applications for Electrofilm Solid Film Lubricants.

Electrofilm INC.

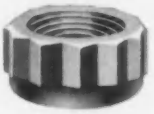
Dept. J-2, P. O. Box 106, North Hollywood, Calif.

three typical "12 POINTER" APPLICATIONS

where wrench clearance was the deciding factor...

ALUMINUM MARSDEN
ATOMIC ENGINEERING
APPLICATION

HI-CARBON SPECIAL
AUTOMOBILE ENGINE
APPLICATION



STEEL "HUGLOCK"
ELECTRIC EQUIPMENT
APPLICATION

The "12 POINTER" Nut Design allows the use of thin wall-socket wrenches (smaller wrench clearance) compact design . . . It provides increased bearing areas, permitting use with softer surfaces without gouging — precise torquing and hopper feeding are other features. The uniformity of this nut makes practical reproducible torques, from part to part and from batch to batch. "12 POINTER" is made in all comparable dimensions, in all popular sizes of standard nuts, as well as "Huglock" and "Marsden" locknuts . . . Send for twelve-page brochure that supplies complete specifications, engineering data and prices.

NATIONAL MACHINE PRODUCTS COMPANY

Manufacturer of Standard and Special "12 Pointer and Hexagon Nuts..."Huglock" and "Marsden" locknuts.

44253 Utica Rd., UTICA, Michigan

inconsistencies with other drainage fittings standards. The requirements of the Report of the Coordinating Committee for a National Plumbing Code were given full consideration. Where precedence could not be found either in existing standards or in the engineering files of the interested manufacturers, special research was conducted to establish correct wall thicknesses and joint lengths.

Basic Processes of Gaseous Electronics

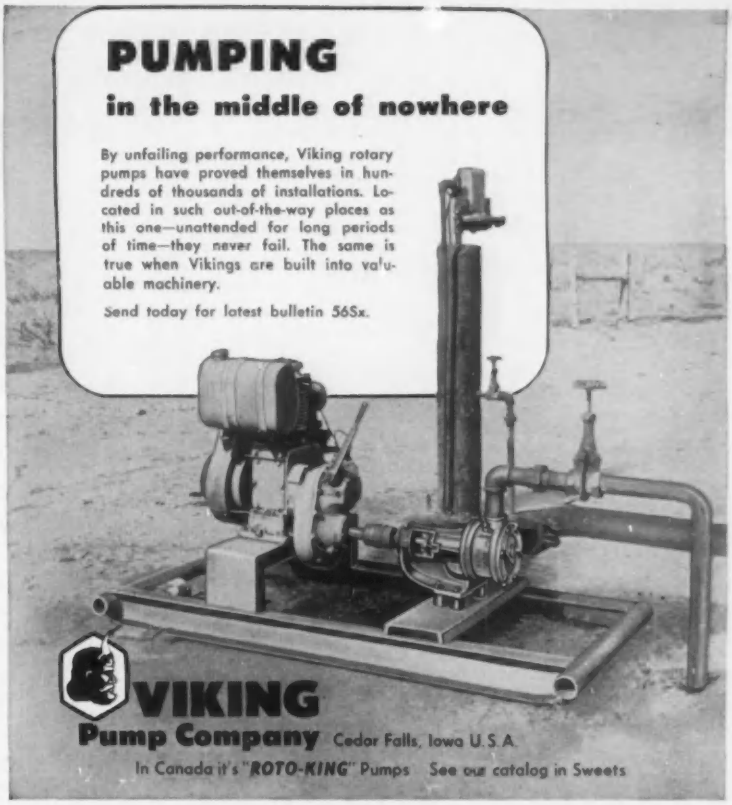
LEONARD B. LOEB, *Professor of Physics, University of California, Berkeley, Calif.* 9½ x 6½ *in.*, 1012 pp. *Published by University of California Press, Berkeley 4, Calif.* $13.50.

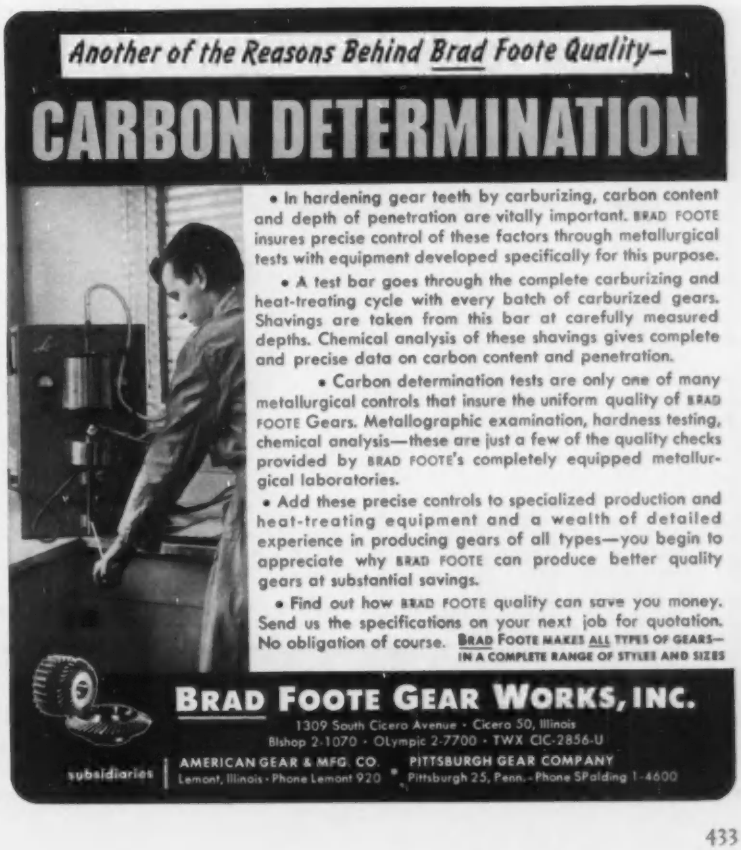
This book deals with basic atomic, electronic, molecular and kinetic mechanisms leading to the electrical behavior of gases, and thus facilitates an understanding of the actual properties of electrical breakdown in gases.

The subjects considered in detail are: ionic mobilities, diffusion of carriers in gases, velocities of electrons in gases, distribution of energy of electrons in a field, formation of negative ions, electrical conduction in gases, ionization by collision of electrons—the first Townsend coefficient. Simplified kinetic-theoretical introductions to each topic are followed by accounts of more esoteric advances, based on recent experimental findings and theoretical developments. Detailed mathematical analyses are not included, but the approach is sufficiently analytical to indicate the physical theory underlying the study.

Although directed primarily to the physicist, chemist or engineer, the book is intelligible to readers with a knowledge of basic atomic structure and relatively little kinetic theory.

Rapid advances in experimental physics have necessitated thorough reconsideration of fundamental processes. The author and his collaborators present latest techniques and methods, together with a critical evaluation of results. Of particular interest are most recent and reliable values for physical quantities of standard gases of known purity. An appendix summarizes important material presented at Seventh Gaseous Electronics Conference, Oct. 1954.


PUMPING
in the middle of nowhere
By unfailing performance, Viking rotary pumps have proved themselves in hundreds of thousands of installations. Located in such out-of-the-way places as this one—unattended for long periods of time—they never fail. The same is true when Vikings are built into valuable machinery.
Send today for latest bulletin 56Sx.
VIKING
Pump Company Cedar Falls, Iowa U.S.A.
In Canada it's "ROTO-KING" Pumps See our catalog in Sweets


Another of the Reasons Behind Brad Foote Quality—
CARBON DETERMINATION
• In hardening gear teeth by carburizing, carbon content and depth of penetration are vitally important. BRAD FOOTE insures precise control of these factors through metallurgical tests with equipment developed specifically for this purpose.
• A test bar goes through the complete carburizing and heat-treating cycle with every batch of carburized gears. Shavings are taken from this bar at carefully measured depths. Chemical analysis of these shavings gives complete and precise data on carbon content and penetration.
• Carbon determination tests are only one of many metallurgical controls that insure the uniform quality of BRAD FOOTE Gears. Metallographic examination, hardness testing, chemical analysis—these are just a few of the quality checks provided by BRAD FOOTE's completely equipped metallurgical laboratories.
• Add these precise controls to specialized production and heat-treating equipment and a wealth of detailed experience in producing gears of all types—you begin to appreciate why BRAD FOOTE can produce better quality gears at substantial savings.
• Find out how BRAD FOOTE quality can save you money. Send us the specifications on your next job for quotation. No obligation of course. BRAD FOOTE MAKES ALL TYPES OF GEARS—IN A COMPLETE RANGE OF STYLES AND SIZES
BRAD FOOTE GEAR WORKS, INC.
1309 South Cicero Avenue • Cicero 50, Illinois
Bishop 2-1070 • OLympic 2-7700 • TWX CIC-2856-U
subsidiaries
AMERICAN GEAR & MFG. CO. Lemont, Illinois • Phone Lemont 920
PITTSBURGH GEAR COMPANY Pittsburgh 25, Penn. • Phone SPalding 1-4600

Light metals design tips

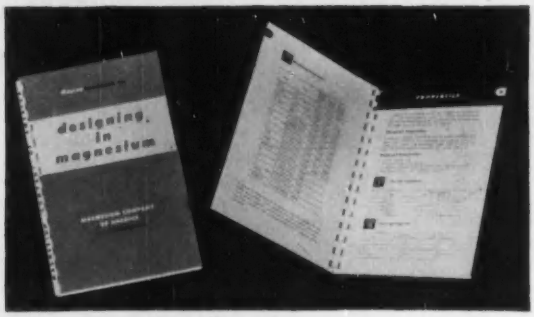
2nd offer

Magnesium Design Handbook available again

In the November, 1955, issue we offered to send a free copy of our Magnesium Design Handbook to any PRODUCT ENGINEERING reader who was interested. Although we were able to furnish a copy to everyone who requested one—in doing so we completely exhausted our supply.

Since then we have had a new supply printed and bound, and we can again offer copies to you. No obligation, of course.

To get your copy of this useful Design Handbook, use the PRODUCT ENGINEERING Reader Service Card enclosed with this issue, or write direct to Magnesium Company of America, Light Metals Fabrication Division, East Chicago 27 Indiana.



Free new handbook of helpful data for designing in magnesium

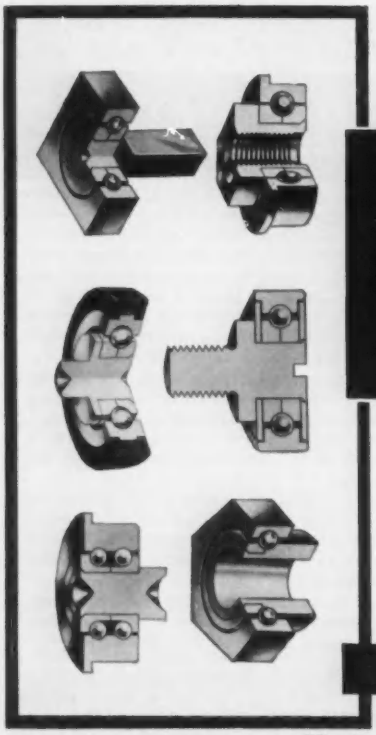
This new handbook—complete with tables and graphs—will answer many of your questions about designing structural assemblies of magnesium. There are complete sections on design, properties, metal working, surface treatment, assembly, and other related subjects.

You'll find helpful data on working stresses, bend radii, spotwelding, shear strengths, riveting, machining and bolting.

Copies are available without charge while the limited supply lasts.

And remember, whenever light metals can be used for your parts or products, Magcoa engineers can help you design them and Magcoa fabricating facilities can produce them for you.

MAGNESIUM COMPANY OF AMERICA magcoa
LIGHT METALS FABRICATION DIVISION • EAST CHICAGO 27, IND.



UNGROUND BALL BEARINGS

For All Industries

KILIAN

Long life and service are assured you because —

1. All component parts are machined from steel bars.
2. Each component part is properly heat treated.
3. Every Kilian Bearing is designed for a specific application.

Neoprene and Nylon tired outer races are available where quiet operation is desired.

Distributors in All Principal Cities ***Catalog on Request***

KILIAN MANUFACTURING CORP.
SYRACUSE, NEW YORK, U. S. A.

ASSOCIATED COMPANIES: Kilian Manufacturing Corp. (Canada), Ltd. 240 Fleet St. East, Toronto 2B, Ont. | Fischer Bearings (Canada), Ltd. 240 Fleet St. East, Toronto 2B, Ont. | Kilian Steel Ball Corporation 100 Wellington St., Hartford, Conn.

OUR READERS SAY . . . . . .

Letters should be addressed to the Editor, *Product Engineering*, 330 W. 42 St., New York 36, N. Y.

Comeback

To the Editor:

I am now in the process of reading your article "Germany's Amazing Comeback," in the Jan. issue of *Product Engineering*. So far I find it very interesting and, in particular, I like the use of the word "energy" in the subtitle. As we both know, an individual of modest endowments who applies himself energetically to the appointed task will accomplish more than the talented rascal who indulges in scientific boondoggling.—E. HURST
Fall River, Mass.

Tolerance Systems

To the Editor:

We are of the opinion that there is a great deal of information in the article "The Use of Tolerance Systems" in the Feb. issue of *Product Engineering*, which we would like to make available for student use in our courses.

Have you made any provisions for reprints of this article? If so, can you quote us prices for purchasing quantities of this article?—J. P. COVAN
Agricultural & Mechanical College of Texas
College Station, Texas

Ed–Because of the large demand we have had for reprints of this article, we have now put the story back on press and it is now available again. It sells for $0.25 per single copy, $0.23 per copy in lots of 100 or more.

To the Editor:

The ABC standard in H. G. Conway's article, "The Use of Tolerance Systems," in the Feb. issue has a good bit of virtue and obviously represents a great deal of statistical effort. However, the table opposite page 166, with the heading "Clearance Fits, Transition Fits and Interference Fits", be-

(Continued on page 437)

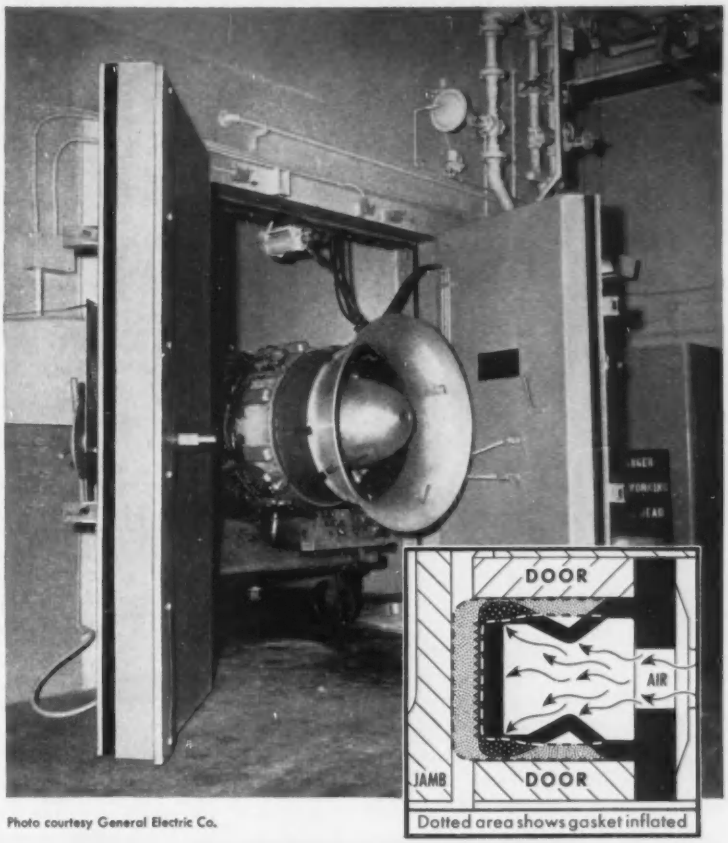


Photo courtesy General Electric Co.

Pneumatic Rubber *Door Seal* Muffles Test Cell Noises

To more effectively suppress noise, General Electric jet engine test cells are equipped with a unique pneumatic rubber door seal. Mounted on door perimeter, this seal is designed to expand proportionally and insure a perfect seal over its entire sealing surface *including the corners*. Not only does this gasket dampen the noise but it permits more accurate testing through quieter working conditions.

Continental engineers developed this pneumatic gasket for this and similar applications. Compounded of special flex-resistant rubber, this versatile gasket can be operated with intermittent flexing cycle *or* as a continuous seal—can be adapted to various other types of doors—for *either* pressure or vacuum rooms.

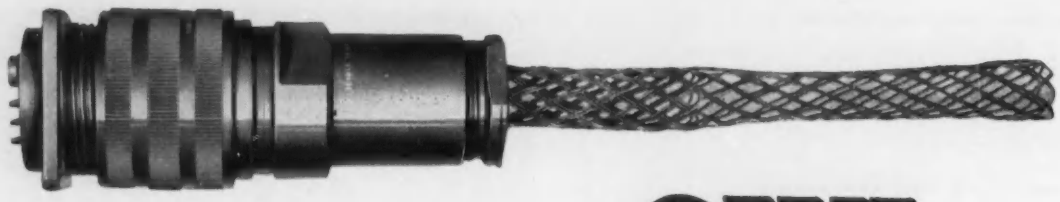
The design of this gasket typifies the engineering skill offered by Continental. When you need "engineered rubber parts"—molded or extruded—enlist the service of specialists—consult Continental.

Engineering Catalog.

In addition to custom-made parts, Continental offers an extensive line of standard grommets, bushings, bumpers, rings and extruded shapes. Hundreds of these are shown in the No. 100 Engineering Catalog. Send for a copy or refer to it in Sweet's Catalog for Product Designers.

Another achievement in **RUBBER**
engineered by **CONTINENTAL**

CONTINENTAL RUBBER WORKS • 1982 LIBERTY ST. • ERIE 6 • PENNSYLVANIA



Presenting the New QWL Bendix® ELECTRICAL CONNECTOR

A HEAVY-DUTY WATERPROOF POWER AND CONTROL CONNECTOR FOR USE WITH MULTI-CONDUCTOR CABLE

This new QWL Bendix* Electrical Connector was designed for and is being used principally on ground-launching equipment for missiles and ground radar equipment.

Obviously, for this important type of service only the highest standards of design and materials are acceptable.

That's why it will pay you to specify the Bendix QWL Electrical Connector for any job that requires exceptional performance over long periods of time.

QWL outstanding features:

1. It combines the strength advantages of machined bar stock aluminum with the shock-resistant qualities of a resilient insert.
2. A modified, double stub thread provides for speed and convenience in mating and disconnecting and the special tapered cross-section thread design resists loosening under vibration. The threads can be easily hand cleaned if contaminated by a substance such as mud or sand.
3. An Alumilite 225 hard anodic finish is used which gives a case hardening to the aluminum surface. This finish offers outstanding resistance to corrosion and abrasion.
4. The cable-compressing gland used within the cable accessory accomplishes both a firm anchoring of the cable and effective waterproofing for multi-conductor cables. Neoprene sealing gaskets are used at every joint to insure a watertight connector assembly.
5. The cable accessory is designed to accommodate a Kellems stainless steel wire strain relief grip for additional cable locking.
6. A left-hand thread is used on the cable accessory to prevent inadvertent loosening.
7. High-grade copper alloy contacts are used which provide for high current capacity and low voltage drop. The famous Bendix closed-entry socket is used for contacts sizes 12 and 16.

*TRADEMARK

Bendix SCINTILLA DIVISION OF Bendix AVIATION CORPORATION
SIDNEY, NEW YORK

Export Sales and Service: Bendix International Division, 205 East 42nd St., New York 17, N.Y.
Canadian Representatives: Aviation Electric Ltd., 200 Laurentien Blvd., St. Laurent, Montreal 9, Quebec

---

HEYCO NYLON STRAIN RELIEF BUSHINGS CUT PRODUCTION COSTS AND IMPROVE PRODUCT QUALITY

Approved

With Heycos it's no longer necessary to tie wire knots or use insulating grommets. Product life is increased and product appearance is greatly enhanced.

HEYMAN MANUFACTURING COMPANY
Kenilworth 3 New Jersey

HEYCO

Send wire sizes for free samples and specifications.

M·F Uni-Torque®

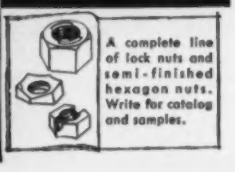
HOLDS THE LINE!

CONSTANT TORQUE NUT-BY-NUT KEG-BY-KEG MEANS A SMOOTH-RUNNING PRODUCTION LINE

Here's *rhythm* for your production line! SET YOUR AIR-WRENCH, SET YOUR TEMPO—and *keep it up*, keg after keg!

Constant torque means fewer rejects, too—because equalized bolt tension keeps your product true to original design. (Check a batch of your present lock nuts for torque *consistency*, nut-by-nut . . . it means everything when *bolt-tension* is a design factor.)

MAC LEAN-FOGG
Lock Nut Company
5535 N. Wolcott Street
Chicago 40, Illinois



A complete line of lock nuts and semi-finished hexagon nuts. Write for catalog and samples.

MACK TRUCK
Specifies Ep Co
INVESTMENT CASTING
for Vital Part

Bulldog Symbol of Mack Trucks Sturdiness and Dependability

"EPCO Cast lever used by Mack Diesel trucks and buses on hydraulic governor control."

INVESTMENT CASTINGS IN ANY CASTABLE ALLOY EXCEPT MAGNESIUM

Mack engineers specified an EPCO Investment Casting on the above part that was previously machined from ½ inch flat stock.

EPCO Cast in SAE 1045 steel ready for use except for tapping of ¼-20 thread, the lever was made at less cost and well within Mack's high quality standards.

EPCO Cast levers have been in constant use since 1947, and have performed with the same rugged dependability expected in a Mack Bus or Truck.

Get an EPCO quotation before machining or assembling your intricate parts.

Ask about our Vacuum Casting Process for increased quality control

Ep Co
ENGINEERED
PRECISION CASTING CO.

Box PE 68 Matawan, N. J.

cause of the generalizations in the comment column, restricts the use of the data to the "experienced designers or specialists" mentioned in the text of the article.

It is my belief, that to be acceptable for use in the average engineering department, this standard requires an "application" chart. Most of the ball and roller bearing manufacturers include a limited list in their catalogs as a guide for selection of housing and shaft fits.

It is readily recognized that the cost of collecting an extensive list of fit applications is a costly project, but the saving to industry of a workable standard is immeasurable. If my small voice can add encouragement to those engaged in this project, it is herewith added to those others who have spent hours searching for application data.

—Marvin O. Young
Georgetown, Del.

Four-Wheel Drive

To the Editor:

In the Jan., 1956 issue of *Product Engineering*, we noted on page 7 the article concerning Harry Ferguson's full four-wheel drive development.

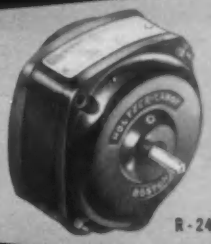
In this article, you mention, "To compensate for spinning on ice, these differentials are limited in their action by calibrated free-wheeling elements which distribute driving torque and braking according to the road needs of each of the four wheels. (A similar system is used in some earth moving machinery.)"

We will greatly appreciate your advising where a more detailed description of the differential system can be obtained, and, also, will give us the specific name or make of the earth moving machinery which uses a similar system.—W. J. Adams, Jr.
San Jose 6, Calif.

Ed—This system is used by Clark Equipment Co., Benton Harbor, Mich., on their tractor-shovel. Also, Packard has developed a non-skid differential which seems to operate on the same principle as the Ferguson design. A detailed description of Packard's design will appear in the Product Design section of our March issue.

We do not have additional information on the Ferguson-design. For this, write direct to: Patrick Dolan Associates, 35 Park St., London W 1, Eng.

HOLTZER-CABOT



R-24 Motor

Synchronous and Induction Capacitor Type Motors

R-25 Motor

R-24. Typical applications for this reversible, 4-pole induction motor are in servo mechanisms, as a balancing motor in recording instruments or as a control motor for voltage regulators. It has low rotor inertia for fast response applications. When operated 2 phase, it can be controlled electronically; or operated single phase as a permanent split capacitor motor.

R-25. Typical uses are for recording instruments, dictating and adding machines. Approximately 2½" in diameter, it is available in either induction or synchronous construction with reversible rotation.

Both the R-24 and R-25 are available with gear case speeds from 1/2 to 3600 RPM, torque ratings up to 75 oz. inches or higher, and single phase, 2 or 3 phase.

HC NP

HOLTZER-CABOT MOTOR DIVISION
NATIONAL PNEUMATIC CO., INC.
125 Amory Street, Boston 19, Mass.

GENTLEMEN: Please send me data sheets on the Holtzer-Cabot R-24 and R-25 Size Motors.

Please have representative call _____ (date)

Name _____

Company _____

Street _____

City _____ Zone ____ State _____

Char-Lynn

HYDRAULIC HORSEPOWER PRODUCTS

HI-LO-PAC PUMP
Model 600—In one compact unit offers: 2 pumps (gear type), 2 valves (single & double), 2½ gallon reservoir, relief valve (1000 psi), filter, delivery up to 12 gpm. Tractor Mounting Kits available.

HYDRAULIC RAMS
Model 1032 *Strokontrol Ram* has 3⅛" bore; 8, 13 or 16" stroke. Double action with hydraulic depth stop.
Model 1002 *Horsepower Ram* has 3" bore; 8, 10, or 12" stroke. Double action converts to single action.

HORSEPOWER VALVE
Model #60 with Holdkontrol provides manual or automatic return to neutral. Has built-in 1000 psi pressure relief valve. No additional parts to convert from double to single acting.

HORSEPOWER PUMP
Model 400—A basic high-speed Gerotor type pump. Delivers 10 gpm at 1750 rpm. Maximum pressure 1500 psi.

HYDRA-SEAL COUPLER—Model 730 Hose Coupler allows free flow when connected. Self-sealing on break-away... Oil sealed in, dirt sealed out. Free flow allows maximum operating efficiency.

Hydraulic Horsepower To Serve You Better

CHAR-LYNN COMPANY

Dept. PE4 2843-26th Avenue South, Minneapolis 6, Minnesota

Member National Fluid Power Association

Char-Lynn COMPANY

For more information— WRITE FOR FREE CATALOG!

*World's Smallest**

Mercury *Plunger-Type* Relay

EBERT'S *NEW* MINIRELAY

Proven in Use For All Loads Up to 20 Amps

Hermetically Sealed Explosion-Proof! No Sparks!

Millions of Trouble-Free "Makes & Breaks"

Forget it once it's Installed!

Competitively Low Priced

35 Millisecond Fast Action!

Installs in one minute!

*3-1/2" H x 1-3/4" W x 1-1/2" D

20 AMPS/115 V. AC • 10 AMPS/230 V. AC • 6.5 AMPS/120 V. DC • 3.5 AMPS/220 V. DC • 1.5 Hp./115, 230 or 440 V. AC • ⅓ Hp./120 and 220 V. DC

Available normally open or normally closed, SPST

FREE fact file-Write today

EBERT ELECTRONICS CORP.

212-25 Jamaica Ave., Queens Village 28, N. Y.

NEW APPLICATIONS AND SAMPLES OF INDUSTRIAL FELT*

*made to S.A.E. and Federal Govt. Specifications

SEND FOR YOUR FREE COPY TODAY!

CONTINENTAL FELT *fills hundreds of jobs daily.*

Ask for booklet *PI*

CONTINENTAL FELT COMPANY, INC. 1905
22-26 WEST 15th STREET NEW YORK 11, N. Y.

PRESS PREVIEWS

General Electric Enters Industrial Computer Field

The General Electric Company has actively entered the industrial computer field through a broadening of its computer activities from specialized engineering and military lines. The move includes integration of the company's widespread computer operations with the establishment of an Industrial Computer Section at Electronics Park, Syracuse, N. Y.

William J. Morlock, general manager of the Division's Technical Products Department, said that integration of the company's computer activities would place General Electric in a better position for aggressively promoting and marketing a full line of computers.

Today's move, he said, is keeping with "the company's established leadership in the field of industrial electronics and is designed to complement that leadership in the rapidly expanding age of automation." Plans disclosed by Mr. Morlock to expedite the company's move into the competitive market for computers include: Centralization of General Electric's computer activity into the new Industrial Computer section, thus combining under one operation the company's widespread computer-development programs; immediate organization of engineering, marketing and sales components in the new section; four managerial appointments for establishment and staffing of a full-scale operating section, and tailoring of an advanced development engineering program to fit over-all requirements of the new section.

Appointment of H. R. Oldfield, Jr., as general manager of the Industrial Computer Section also has been announced. Mr. Oldfield was formerly manager of the G-E Microwave Laboratory at Stanford Industrial Park, Palo Alto, Calif. He has had extensive managerial experience in the General Electric Company, having previously served as manager of the G-E Ad-

(Continued on page 441)

when you need
WIRE CLOTH PARTS

Call Cambridge
for accurate production, fast delivery

Our engineers in the field and in the home office are ready to discuss your wire cloth fabrication problems at all times. They'll help you select weaves, mesh sizes and metals to meet your needs and draw up prints for your OK . . . or, they'll start the factory working from *your* prints. Whether orders are small or large, you're assured of strict adherence to specifications by close manufacturing supervision.

Your parts will be fabricated from any conceivable type of industrial wire cloth, selected from the complete Cambridge line. Specifications from the finest to the coarsest mesh in any metal or alloy are usually met from stock, assuring the speediest delivery. Individual loom operation and careful inspection provide the maximum in mesh size uniformity and mesh count accuracy.

IF YOU BUY WIRE CLOTH IN BULK . . .

You can get immediate delivery on large or small orders for the most frequently used types of cloth. If your needs are not in stock, we'll schedule our looms to get your material to you without delay.

LET US QUOTE on your next order for fabricated parts or wire cloth in bulk. Call your Cambridge FIELD ENGINEER—he's listed under "Wire Cloth" in your classified telephone book. OR, write direct for FREE CATALOG and stock list giving full range of wire cloth available, description of facilities and metallurgical data.

The Cambridge Wire Cloth Co.

WIRE CLOTH · METAL CONVEYOR BELTS · SPECIAL METAL FABRICATIONS

Department P, Cambridge 4, Maryland

OFFICES IN PRINCIPAL INDUSTRIAL CITIES

the Computers Say Carbon

Much of today's material selection is performed by the digital computer. Tabulations of desired properties for a specific application are fed to these machines, and the material selected is most often – carbon. The many versatile physical properties of carbon make it excellent for a diversity of applications...to name a few:

Good Electrical Conductivity – Carbon brushes and contacts, vacuum tube anodes, grid rectifier anodes, and welding products.

Resistance to Corrosion – Bearings for use in acids; plating electrodes; pipe for handling chemicals; linings for acid tanks.

Self-Lubricating – Carbon piston rings; dash pot plungers; nozzles; seals; orifices and inserts in metal bearing surfaces and brake shoes.

No Deformation at High Temperatures Sintering boats, brazing boats and fixtures; molds for powder metallurgy; dies for continuous casting; forms for metal to glass sealing.

Resistance to Severe Thermal Shock – Liners for rocket nozzles, electric furnaces; hearth and wall sections of blast furnaces.

Easily Machined and Fabricated–Carbon structural shapes–beams, blocks, plates and rods.

Let the computer result be your guide and consider carbon for your specific application. Speer Carbon Company can provide practically any product for your need, made to exacting specifications for shape, size, and composition. For information return coupon.

SPEER Carbon Co.

St. Marys, Pa.

Please send information on carbon for use in_____

Name_____

Title_____

Address_____

City_____ State_____

too many hurdles?

Are there too many obstructions in your professional path? Too many barriers keeping you from making the engineering progress you should?

Then, investigate these opportunities at Fairchild Aircraft Division – where you can be sure of a clear field to move ahead as fast as you're able.

Aircraft Engineers with supervisory experience in one or more of these qualifications:

- Design Project Engineers
- Design Coordinators
- Design Engineers for Sheet Metal Structure, Hydraulic Systems, Landing Gears, Control Systems, Equipment and Furnishings, Electrical and Electronics Installations, Power Plant Installations
- Stress Engineers for both Sheet Metal Structures and Mechanical Systems
- Weight Control

Layout Designers and Draftsmen

Project Coordinators and Administrators

You'll like the Fairchild working climate, and you'll like living in the attractive Cumberland Valley – excellent housing, schools, recreational facilities . . . close to urban Baltimore and Washington.

Send your resume today to Louis Fahnestock, Director of Engineering.

...WHERE THE FUTURE IS MEASURED IN LIGHT-YEARS!

FAIRCHILD

AIRCRAFT DIVISION • HAGERSTOWN, MARYLAND

A Division of Fairchild Engine and Airplane Corporation

vanced Electronics Center at Cornell University, Ithaca, N. Y., and manager of plans and product applications in the laboratories department at Syracuse.

According to Mr. Morlock, the Industrial Computer Section will manufacture and sell types of computers, including analog, digital and simulators, as well as special components used with computing equipment.

General Electric has developed in the past specialized computers for many of its own activities. Included among these is the network analyzer, a huge machine used to determine the most economical operation of power systems. It can reproduce in miniature hundreds of miles of transmission lines in vast power networks. In another operation, the Company uses a specialized digital computer as an aid in designing guided missiles and other defense products. This computer can make five thousand additions of five-digit numbers per minute.

A few years ago General Electric built "OARAC", for the Air Force, which contained one of the largest "memories" then incorporated in any computing device. Capable of doing as many as 100 calculations per second, this machine delivers rapid-fire answers in typewritten form to mathematical problems.

Computers to be developed and manufactured by the new section are expected to range in size from "pocketbook" editions for production control use, to giant machines filling three average-sized rooms. From today's two primary uses of computers—in engineering-mathematics and data-processing—the G-E executive sees their use spreading to such things as patent searching, stock market transactions, letter-mail handling, bank accounting and the use of computer techniques in advanced mechanization and automation of factory production.

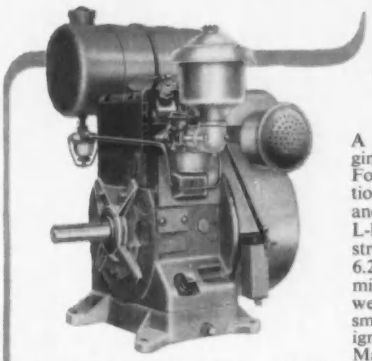
Eastman Kodak Forms New Division

The formation of an Apparatus and Optical Division of the Eastman Kodak Company has been announced by Thomas J. Hargrave, chairman, and Albert K. Chapman, president. At the same time, a realignment of certain

(Continued on page 443)

Step up performance of your power equipment...with one of these

3 New Onan Engines



MODEL AJ

Single-cylinder, gasoline-powered

5.5 H.P.

A compact, rugged, high-performance engine developing 5.8 H.P. at 3600 R.P.M. For heavier-duty applications on construction machinery, farm and garden equipment and similar products. Four-cycle; air-cooled; L-head; vertical cylinder; 2¾" bore; 2½" stroke; 14.9 cubic inch piston displacement; 6.25:1 compression ratio. Removable aluminum alloy cylinder head; fully counterweighted and balanced crankshaft for smooth operation. High tension magneto ignition. Mounted fuel tank and muffler. Manual pull-rope starting (recoil starter or electric starting optional).

Overall dimensions: *Length (incl. shaft) 15⅛", Height (with tank) 20", Width 20¼".* **Weight:** *(Dry with accessories) 78 pounds.* **Power take-off:** *Crankshaft extension 3¼" long, 1" diameter.*

MODEL CCK

Two-cylinder, gasoline-powered

12.9 H.P.

Horizontal, two-cylinder opposed design gives this engine exceptionally smooth, quiet operation. Develops 12.9 H.P. with accessories at 2700 R.P.M. Pressure air-cooled; 4-cycle; 3¼" bore; 3" stroke; 50 cubic-inch piston displacement; 5.5:1 compression ratio. Extra-large bearing surfaces; high tension magneto ignition; governor regulation within 5%. Short, extra heavy crankshaft. Removable aluminum cylinder heads. Full pressure lubrication. Manual pull-rope starting. (Recoil starter optional).

Overall dimensions: *Length (incl. shaft) 14¾", Width 19½", Height 17⅞".* **Weight:** *(Dry, with std. accessories) 148 pounds.* **Power take-off:** *Crankshaft extension, 21⅝" long, 1½" diameter.*

MODEL DRP

Two-cylinder, air-cooled Diesel

15 H.P.

Where heavy duty performance, economy and safety are important factors, this air-cooled full Diesel engine has outstanding advantages. Electric starting; horizontal, 2-cylinder opposed design; develops 15 H.P. with accessories at 2300 R.P.M.; 4-cycle; 3½" bore; 3½" stroke; 67.3 cubic inch piston displacement; 17.3:1 compression ratio; forged steel crankshaft and connecting rods; extra-large bearing surfaces; full pressure lubrication; 12-volt generator.

Overall dimensions: *Length (incl. shaft) 26⅛", Height 28", Width 30¼".* **Weight:** *(Dry, with accessories) 516 pounds.* **Power take-off:** *Flywheel for disc drive; accessory crankshaft extension 4" long by 1½" diameter.*

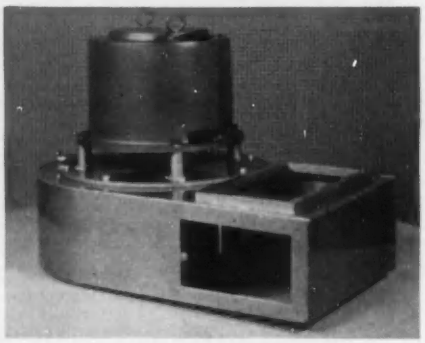
Write for complete specifications

D. W. ONAN & SONS INC.

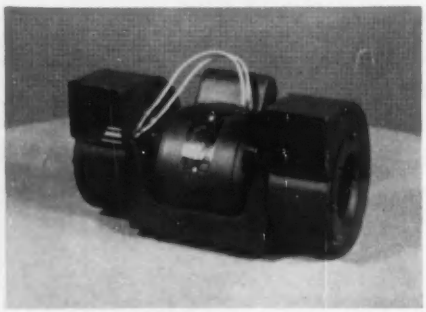
Onan ELECTRIC PLANTS

4032 University Ave. S.E., Minneapolis 14, Minnesota

COMPACT Peerless® Blowers for OEM Applications



DIRECT DRIVE blower equipped with space saver motor. Custom-built by Peerless for high pressure, big volume air delivery. Designed to customer's specifications.



TWIN BLOWERS for use in electronic equipment. Built to customer and government specifications. Protected against fungus and high temperatures.

● Practical experience and complete production facilities at Peerless Electric help us solve equipment cooling problems quickly and efficiently. We work with many of the nation's top producers of electronic equipment. We design and build our own motors. We design, engineer and build our own fans and blowers. From start to finish we have complete control of our products. Let our engineers tackle your equipment cooling problems. We will work to your size restrictions and give your fans or blowers the capacities and qualities that make your equipment operate best.

WRITE FOR PEERLESS BULLETIN SDA-160

FAN AND BLOWER DIVISION

THE Peerless-Electric® COMPANY

FANS · BLOWERS · ELECTRIC MOTORS · ELECTRONIC EQUIPMENT
1406 W. MARKET ST., WARREN, OHIO

VELLUMOID

A Gasket that seals tight . . . and stays TIGHT

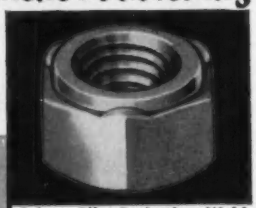
- Some "beater mix" materials are highly oil absorbent and as a result don't make tight, lasting seals.
- VELLUMOID'S VELBUNA WG-1 AND WG-4 are firm, dense Buna N and fibre combinations. The result is a highly oil resistant gasket with high torque retention . . . that really seals.
- We'll gladly prove our point. Let us send you samples to test on difficult applications that must be sealed permanently . . . and economically.
- The Vellumoid sales engineer in your territory is always available for consultation.

VELLUMOID COMPANY
56 ROCKDALE ST. · WORCESTER, MASS.

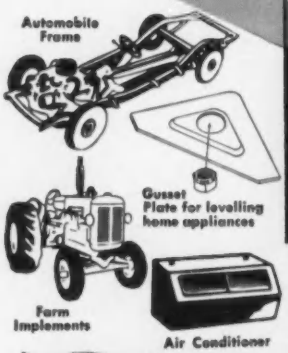
WHEN YOU NEED Quicker Fastening FOR

- Blind Assemblies or
- Extra Threaded Depth at less cost...

use one of these 2 WELD NUTS



Gripco Pilot-Projection Weld Nut. Circular pilot designed for quick, easy positioning of nut over bolt hole for instant resistant welding. No jigs, no fumbling, no waste of time. Furnished with or without famous Gripco locking feature.



Gripco Countersunk Weld Nut. Eliminate time-wasting retapping of nuts after welding. Exclusive countersunk nut bottom does away with fouling of nut threads by weld spatter. Available with or without Gripco locking feature.

Write for sample and full details. NO. 114

GRIP NUT COMPANY
308-J S. Michigan Ave. · Chicago 4, Ill.

functions of the Kodak sales department has been made to give the new division its own sales organization and to further increase the effectiveness of the company's sales department.

The Apparatus and Optical Division, located in Rochester, includes two of the company's Rochester manufacturing plants—the Camera Works and Hawk-Eye Works. These plants manufacture cameras, optical instruments, and photographic accessories. Sales functions relating to apparatus service, military and special products, still cameras, Cine-Kodaks, photographic accessories, and professional apparatus have been transferred to the new division. In addition, the division will also have its own financial, accounting, and related departments.

"The new division has been organized to help keep the company operating as efficiently as possible in relation to present and expected future requirements of its apparatus and optical business," Hargrave and Chapman said. "Kodak's management believes that bringing these related operations together as a major division of the company will make research, manufacturing, sales, and other activities more effective."

Demand for Cycolac Springboards New Plant

Roy C. Ingersoll, President of Borg-Warner, has announced that the corporation has undertaken a major expansion in the plastics manufacturing field by appropriating 10 million dollars for the erection of a chemical plant on a recently purchased 322-acre site at Washington, W. Va.

Construction of the plant was necessitated by a market exceeding company expectations for a new thermoplastic resin called Cycolac developed and produced by the Marbon Chemical Division of Borg-Warner. Demand for the new material greatly exceeds the production capacity of the present two Marbon plants at Gary, Ind. The new plant will consist of a series of buildings distributed over nearly one-half of the 322 acres. A substantial section of the plant will be devoted to facilities for processing the Cycolac synthetic resin into a variety of colors.

"The new plant is actual evidence

(Continued on page 445)

IMPORTANT NOTICE!
CIBA
Epoxy
Every drum and bag of
CIBA Epoxy RESINS
carries this exclusive
double check
CIBA
CIBA COMPANY INC. KIMBERTON, PA.
ARALDITE 502
MFG. QUALITY CONTROL
APPL. QUALITY CONTROL
DRUM NUMBER
BATCH NUMBER
To all users of this basic and widely used class of resins, the development of which was pioneered by CIBA researchers, rigid manufacturing and applicational control of Araldite Epoxy Resins at the source of their production, means utmost assurance of quality and uniformity. For further information on how CIBA Epoxies may lead to product improvement and new product development for you, write . . .
Ciba Company Inc., Plastics Division,
627 Greenwich St., New York 14, N.Y.
CIBA
ARALDITE® Epoxies

O-RINGS

are a valve's best friend

Let's face it . . . dripping, leaky valves are just not socially acceptable . . . so, we designed the new Hoke bar stock needle valve with an O-ring stem seal—to give it the right start in life. Result—a seal that will pass a helium leak test and no leaky, messy packing adjustments—ever. No friction either (even at high pressure)—you can operate the valve with a fingertip touch. There's a new, self-aligning spindle which shuts off tight time after time without galling or binding.

As you can see, the Hoke bar stock valve will contribute ease of operation, low maintenance cost and neat appearance to your equipment—hydraulic, pneumatic, instrument panel or test stand. It's available from stock in a wide range of sizes (⅛" to½" pipe) and materials (carbon, chrome or stainless steel and brass) . . . panel mounting, too if you need it. We'd like to send you our Bulletin.

P.S. We've just published a new wall chart on Hoke valves with valuable information on valve sizing and corrosion resistance. May we send you one?

HOKE

HOKE INCORPORATED
Fluid Control Specialists
197 S. DEAN STREET, ENGLEWOOD, N. J.

IF You want to cut production costs

THEN

without machining, you can:

- **ANCHOR BUSHINGS IN DRILL JIGS.**
- **SECURE MAGNETS IN FIXTURES.**
- **ANCHOR SHAFTS IN ALNICO ROTORS.**
- **ALIGN AND SECURE SHAFT BEARINGS, etc.**

Simple procedures for above described in Bulletin A1-

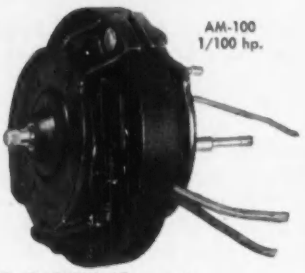
write for it today.

Visit booth No. 236, Design Engineering Show, Convention Hall, Philadelphia, May 14-17, to see these and many other applications.

CERRO DE PASCO CORPORATION
52 East 50th St., New York 22, N. Y.

HEINZE
SUB-FRACTIONAL HORSEPOWER
MOTORS

ANTENNA MOTORS
(used successfully in television rotator service)
LOW VOLTAGE
CAPACITOR TYPE



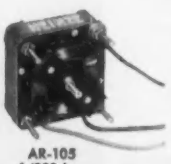
24 VOLT, 60 CYCLE AC operation
Reversible with a switch.

Free load, 3300 rpm, using a 100 mf condenser.

Highly useful in the laboratory and for advertising displays, experimental devices, etc.

Skeleton frame, but can be provided with ventilated case.

Mountings available.

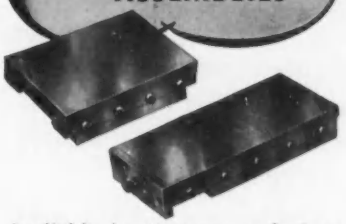


Heinze Electric Co
685 Lawrence Street, LOWELL, MASS

SAVE DESIGNING AND MANUFACTURING TIME
with these
Standard COMPONENTS
OR Special MACHINES

COMPLETE your *special* production equipment faster with *standard* components from this extensive line. Highest precision and quality—many sizes available from stock. *Get complete details!*

STANDARD
Slide ASSEMBLIES



Available in 52 types and sizes. *Basic Type* includes male and female members, gib and gib screws. *Assembled Type* also has return springs, stop screw, Neoprene shield and mounting holes. Sliding surfaces furnished either *Milled* or *Hand Scraped.* Widths from 2″ to 6″—lengths from 3″ to 16″.

STANDARD
Spindle ASSEMBLIES

Available in *Collet Type* for ⅛″, 3/16″ and ¼″ max. capacity collets; *Morse Taper Type* for No. 0 and No. 1 Morse taper shanks; and *Arbor Type* for shankless cutters with 0.375″ and 0.500″ center hole. *Standard Duty* has single row ball bearings at both ends; *Heavy Duty* has double row bearings at front.

WRITE now for FREE catalog!

RUSSELL T. GILMAN, Inc.
1249 Milton Ave.
JANESVILLE, WISCONSIN

of our faith in the boundless future of the plastics industry," Mr. Ingersoll said. "This major increase in our activity in the chemical field is an important part of Borg-Warner's over-all program of expansion and diversification.

"Despite the great increase in the sales of synthetic resins and plastics during post-World War II years, we believe the surface of the market has barely been scratched. Plastics have become a part of our pattern of living.

"Today the average seven-cubic-foot refrigerator contains 22 lb of plastic components compared with one pound in a typical 1935 model. The average automobile today has an estimated 20 lb of plastics as opposed to 7½ lb per car in 1941. The amount of plastics used by the average American family has increased from nine pounds in 1940 to 83 lb in 1955. Within the next five years this is expected to reach over 150 lb.

Cycolac, which is a high impact thermoplastic resin, has been found to have many hundreds of end uses in general industry. Among the diversified end products now being manufactured from Cycolac are beverage dispensers, bowling pins, cosmetic cases, radio-television cabinets, film cases, toys, football face masks, hose nozzles, golf club heads, mop handles, lawn sprinklers, pipes and fittings, recording tape reels, telephone dial wheels, watch cases and various automotive components. Cycolac resin is under test for use in the manufacture of many additional products.

Cycolac resin is described as having the toughness of rubber and approaching the surface hardness of most nonferrous metals. Plumbing pipe made of the material will withstand many hundreds of pounds pressure and will resist corrosion and acids which affect steel and iron pipes. Made into a football mask, it has fully protected its wearer from a series of cloutings by a baseball bat. It has sufficient heat resistance to hold boiling water and soluble enough that it can be sprayed in colors on elastic rubber surfaces but won't chip off.

"While it is indicated that Cycolac resin will receive ever-increasing market acceptance, this acceptance does not necessarily occur at the expense of existing plastics," according to

(Continued on page 447)

LATEST CONTROL DESIGN DATA
for hydraulic, mechanical and electrical applications

Here is complete information on a versatile modern control of interest to every design engineer. Available in models capable of delivering 50 to 400 inch-pounds thrust, Sperry Hydraulic Remote Controls are used extensively by the automotive, aviation, marine and machine tool industries for manual or automatic control of:

- Brakes
- Clutches
- Throttles
- Governors
- Rheostats
- Hydraulic Pumps
- Engine Spark Adjustments
- Engine Mixture Setting
- Hydraulic Transmissions
- Fire Extinguishers
- Feed Mechanisms
- Duplication of Motions

Return coupon for descriptive bulletin. 20-106

Sperry SPERRY PRODUCTS, Inc., Danbury, Conn.

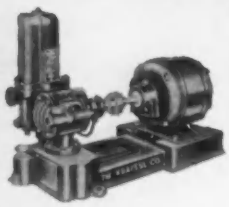
☐ Send Hydraulic Control Bulletin 20-106.
☐ Have representative call.

Name_____
Company_____
Address_____
City_____ State_____

Since 1926. In the application, design and manufacture—pumps, separators, hydraulic accessories

EQUIPMENT FOR FLUID POWER TRANSMISSION

Primary Oil Pumps • Vacuum Powered Transmission and Low Pressure Air Service • Air and Liquid Filters •



Rotary Air Pumps for vacuum bottling

Kraissl's patented, automatic, force-free lubrication and flushing system makes these direct-drive, high-capacity pumps ideal for the special requirements of bottle-filling machinery.

Air-cooled design — or water-cooled models for heavier duty.

Class 21-roller-action pumps are recommended for handling corrosive gases and extraneous matter that might jam with closer clearances. The multi-blade design if the Class 25 pumps gives higher capacity efficiencies and is designed for applications requiring higher degree of vacuum. Where water-cooling is desired for continuous service, the water-jocketed Class 25-WJ models are recommended.

EXCLUSIVE CLASS 26 AIR FILTER

is available as an integral part of each pump up to 10 cfm — to produce oil-free discharge air and also conserve the lubricating oil.

Write today for Bulletins A-1289 and A-1523

KRAISSL CO. Inc.

286 Williams Ave., Hackensack, N. J.

RAWSON

4 PURPOSE COUPLING

Coupled to an engine drive, the spring controlled shoe permits the engine to idle at a predetermined speed. This feature is particularly valuable for warming up purpose . . . wherever a machine is operated intermittently . . . Allows the engine to idle without operating the machine . . . automatically picks up load whenever the engine speeds up and again releases at idling speed.

RAWSON — Starts . . . couples . . . cushions . . . limits load

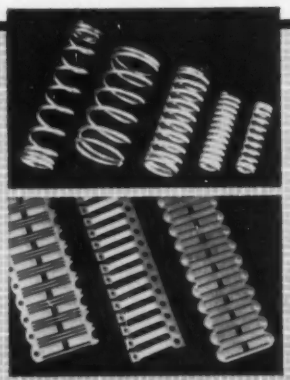
RAWSON COUPLING DIVISION

O. S. WALKER CO. INC., WORCESTER, MASSACHUSETTS

Design and Development Engineers:

Check your SPRING DESIGNS with I-S

The I-S short run department can save you time and money in the planning stage or whenever production quantities required are limited. Precision springs in small lots are produced quickly and economically... designers can check springs for performance and design prior to ordering production runs. If you have a problem, ask I-S specialists for a recommendation on your specific spring applications.



Specify I-S Beryllium Copper Springs for High Strength and Endurance:

For further information on I-S Micro-Processed Beryllium Copper Springs, consult Sweet's Product Design File or write for our latest Catalog.

"MICRO-PROCESSED" I-S BERYLLIUM COPPER SPRINGS

INSTRUMENT SPECIALTIES CO., INC.

234 Bergen Blvd. • Little Falls, N.J.

Telephone: Little Falls 4-0280

Robert Shattuck, President of the Marbon Chemical Division of Borg-Warner. "The unique properties of Cycolac lend themselves to an expanding range of new uses not now filled by other plastic materials.

"As for the market as a whole—statistics will show that the thermoplastic part of the business has grown 35-fold during the last 20 years.

"We in Marbon Chemical and in Borg-Warner feel that the plastics industry today is in about the same position on the industry life curve as was the steel industry in 1880. Then—in 1880—there were horizons unlimited for steel. Today—in 1956—there are horizons unlimited for the chemical-plastics industry."

Lambda Electronics Opens Second Plant

Lambda Electronics Corp., Corona, New York, a manufacturer of regulated and unregulated DC power supplies, has opened a new plant at College Point, N. Y.

According to Lester Dubin, president, when Lambda first started in the power supply business in 1949, the company had to contend with a reluctance on the part of engineers to specify pre-assembled units. Many preferred to build their own. Today, however, says Mr. Dubin, there is practically universal agreement among electronics men that it is far more economical in time and money to buy any one of a number of good makes of power supplies.

Lambda sales are at an all-time high, Mr. Dubin reports. The company contemplates further expansion of its line in 1956, including possible entrance into several new fields of manufacture.

Porter-Cable Predicts Continued Sales Increase

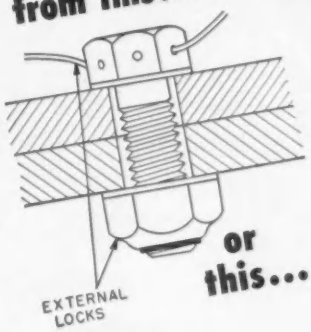
End of the year reports for 1955 indicate that Porter-Cable sales, profits and dividends have established all-time records, according to D. J. Ridings, President. In a formal golden anniversary address, Ridings attributed this success to the "partnership of loyal employee associates

(Continued on page 449)

How to Do Away With Lock Nuts and Lock Wiring

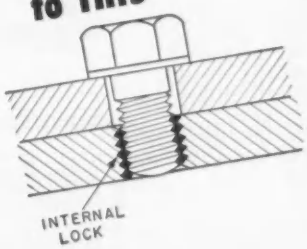
use HELI-COIL* Screw-Lock Inserts

from this...



or this...

to THIS



Screw-Lock Inserts meet AN-N-5b and MIL-N-25027 military specifications for lock nuts.

For years designs requiring lock nuts or lock wiring have plagued designers with problems of space, weight and costs. Each lock nut, even a small one, takes space, has weight and costs money. Every bolt locked with wire requires a through hole in the head, positioning and wiring. The simplicity of many a superior design has been lost due to these cumbersome methods of fastening.

Now for the first time good designers can do away with these "design plaguers." They can accomplish the same end results plus a saving of weight, space and money by a new revolutionary concept in fasteners—*Heli-Coil* Mid-Grip Screw-Lock Inserts. This new fastener is a stainless steel wire insert with locking threads. It can be installed easily and puts the locking effect *inside* the tapped hole—protects the tapped threads for life—and locks the mating screw or the bolt with the same torque as a lock nut. This Screw-Lock Insert not only provides a stainless steel protecting thread, locks the screw or bolt, but most important of all—eliminates the space and weight of a lock nut—the wiring necessary in lock wiring.

Heli-Coil Mid-Grip Screw-Lock Inserts can readily be distinguished from regular non-locking *Heli-Coil* Inserts by their distinctive red color.

*Reg. U. S. Pat. Off.

HELI-COIL SCREW-LOCK INSERTS

Products of Heli-Coil Corporation, Danbury, Conn.

HELI-COIL CORPORATION
164 SHELTER ROCK LANE, DANBURY, CONN.

☐ NEW—Design manual available on regular *Heli-Coil* Screw Thread Inserts.
☐ RUSH complete design data on *Heli-Coil* Mid-Grip Screw-Lock Inserts.
☐ WIRE your nearest representative to phone me at_____
☐ Send me, FREE, *Heli-Coil*, your case history periodical.

Name_____Title_____

Company_____

Address_____

City_____Zone____State_____ ⊕ 3053

☐ Heli-Coil Corporation has an outstanding staff of Thread Fastening Engineers. If your company would be interested in a "Thread Problem Symposium" CHECK HERE.

IN CANADA: W. R. WATKINS CO. LTD., 41 Kipling Ave. S, Toronto 18, Ont.

Linear YJ-70

when conventional packing will not do

Conversion from flammable to non-flammable fluids has created serious packing problems in many hydraulic systems. Ordinary molded seals deteriorate rapidly when non-inflammable fluids are used in the system.

Pioneer research by LINEAR has developed Compound YJ-70 to solve this problem. YJ-70 is not affected by *Skydrol*, *Pydraul*, *Lindol* or mediums that contain *Tri-Cresyl-Phosphate*—provides perfect sealing in systems using these and other diester fluids. At the same time, YJ-70 withstands deterioration and maintains dimensional stability in the usual flammable petroleum base fluids.

This dual compatibility makes packing change over unnecessary . . . no down time for packing replacement . . . assures perfect sealing under all conditions.

Here is another example of LINEAR leadership. Whatever your packing problem, it will pay you to look to LINEAR.

"PERFECTLY ENGINEERED PACKINGS"

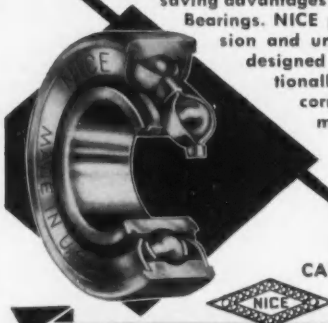
LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILADELPHIA 35, PA.

COST REDUCTION is Product Designers' NO. 1 PROBLEM . . .

AND NICE CAN HELP LOWER COSTS

Product Designers will find many cost saving advantages in the use of NICE Ball Bearings. NICE precision, semi-precision and unground bearings are designed to provide the functionally and economically correct answer to most application problems.



WRITE FOR CATALOG NO. 150

NICE BALL BEARING CO.

NICETOWN • PHILADELPHIA • PENNSYLVANIA

MODEL GHM

SPEED SENSITIVE SWITCHES

Synchro-Start units are available in two body designs for one, two and three switches. The GS series is for a standard distributor take-off with gear or coupling drive and has oilless bronze bushings. The GH body is for standard SAE tachometer drive and runs in oil sealed ball bearings.

These units contain snap action switches rated at 10 Amps.-110 Volts A.C. and can be used for either opening or closing a circuit at any RPM over 500. Adjustable while the engine is running for a plus or minus 20% of set speed.

The model shown here was designed for overspeed shutdown and is made for either automatic or manual re-set. Dust caps can be furnished with a variety of standard or special connector fittings.

SYNCHRO-START PRODUCTS, INC.

Automatic Engine Control Equipment

8151 NORTH RIDGEWAY AVENUE, SKOKIE, ILLINOIS

and foreseighted management who work toward a common goal of profits based on the economical manufacture of quality products."

His report stated that sales of Porter-Cable tools have increased 25 per cent over 1954, and that the company is looking for an increase of 10 per cent during 1956. This expectation is based on the introduction of a number of new products, an increase of 10 per cent in its national sales force, and a 25 per cent addition to its 6000 dealers.

The company has recently purchased the Brown-Lipe-Chapin Plant from General Motors Corporation, Argonaut Realty Division, in Syracuse, New York. The 465,000 sq ft plant cost about one million dollars. The company manufactures a line of over fifty different portable electric tools for homecraftsmen and for industrial, construction and woodworking trades, in addition to a line of lawn and garden power tools.

Recently added to the line is a new electric cultivator for home and professional gardeners. The cultivator can hoe, mulch, aerate the soil, blend in fertilizers and remove weeds without the operator bending or kneeling, according to Porter-Cable. It is said to work up to 50 per cent faster than conventional hand tools. Cultivating tines of this new electric cultivator move in a small circular path thousands of times a minute, breaking the soil into a smooth, crumbly mulch, conducive to healthy plant growth.

N.Y.U. Reports Expanded Industrial Research

Industry-sponsored research at the New York University College of Engineering increased 35 per cent during the past year, Dean Thorndike Saville has announced. Total research activity increased 23.6 per cent, rising from an annual expenditure of $2,235,000 for the period 1953-54 to $2,763,600 in 1954-55.

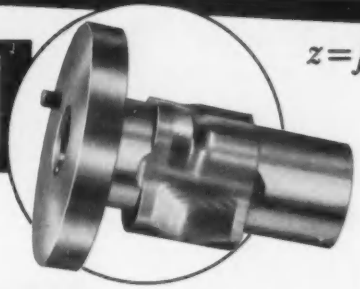
The College conducted research for government agencies and private foundations, as well as for private industry. Faculty members, full-time staff scientists, and graduate students participated in projects ranging from

(Continued on page 451)

3 Reasons for Solving Your Next Control Problem With a 3 DIMENSIONAL CAMS

$z=f(x,y)$

1

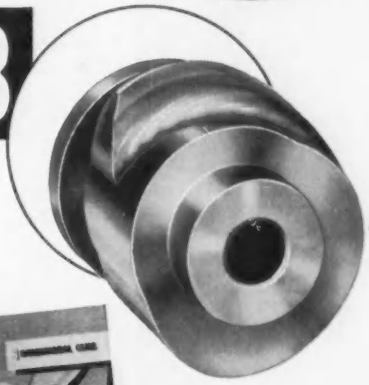


A 3 Dimensional cam can give an infinite number of exact control stations with precise interpolation between stations.

2

A 3 Dimensional cam can accomplish these superhuman "thought" functions in a minimum of space—a square inch or two.

3

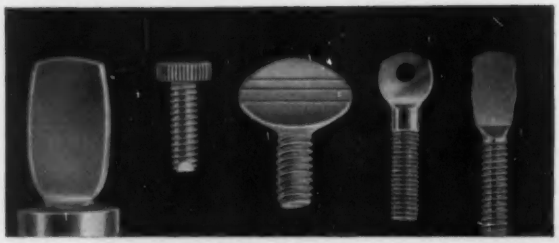


A 3 Dimensional cam is a positive *mechanical* control that eliminates complicated electronics and involved maintenance.

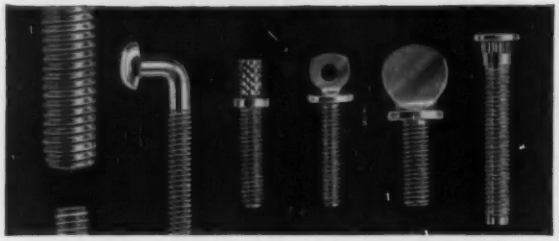
3 Dimensional cams for automation . . . jet aircraft . . . guided missiles . . . machine tool control . . . instrumentation . . . any high precision mechanical control are now being manufactured in production quantities.

Investigate the control latitude and reliability of 3 Dimension cams by Parker—send today for literature.

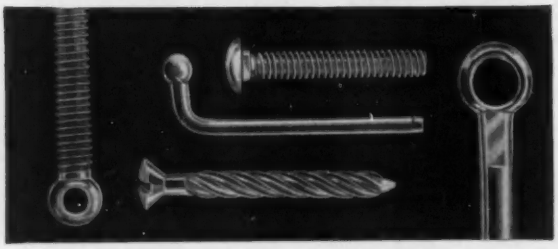
THE PARKER STAMP WORKS, INC.
CAM DIVISION
FRANKLIN AVENUE • HARTFORD, CONNECTICUT
by Parker



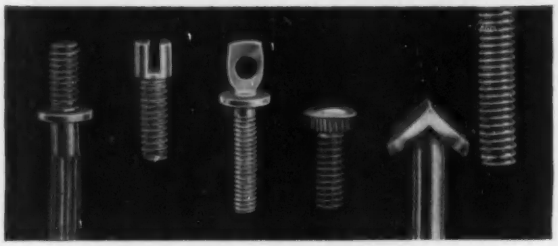
YOU CAN'T BEAT COLD FORMING



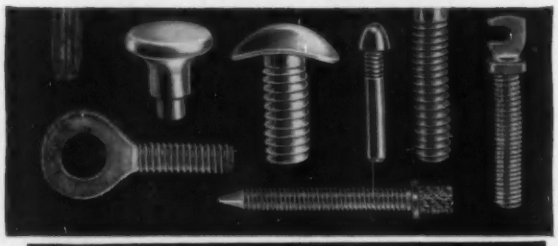
FOR PARTS LIKE THESE—AND



YOU CAN'T BEAT PROGRESSIVE



FOR COLD FORMING . . .



MACHINE SCREWS AND SPECIAL FASTENERS ARE OUR BUSINESS
. . . INCLUDING SQUARE AND HEXAGON MACHINE SCREW NUTS

WRITE FOR OUR CATALOG

THE PROGRESSIVE MANUFACTURING COMPANY
DIVISION OF THE TORRINGTON COMPANY
48 Norwood St., Torrington, Conn.

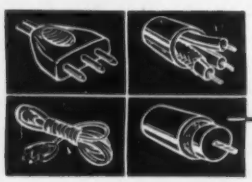
For Power Insulation

AS SPECIFIED

Engineers Call For PHALO

It's just good common sense! Phalo supplies insulated wires, cables and cord sets for many of America's finest products . . . the Phalo reputation for delivering power supply as specified is an enviable one.

Be ready ahead of time for that next power problem. Get Phalo's complete catalog for your files . . . then talk to your nearest Phalo sales representative. His card will be with the catalog we send you!



PHALO
PLASTICS CORPORATION
The Custom Cable House
21-25 Foster Street
Worcester, Massachusetts
Insulated Wires, Cables – Cord Set Assemblies

theoretical studies of Geiger counter properties to the development of sun-powered stills for converting sea water to fresh water.

NYC meteorologists completed an experiment along the entire east coast to determine if large-scale cloud seeding could materially change weather. Air pollution engineers began a study of the Buchanan, N. Y., site of Consolidated Edison's proposed 55 million dollar nuclear electric generating station.

The NYU Research Division, whose staff now numbers 431, established a solar energy research laboratory last year and renovated a building near the campus for research in jet propulsion and other fields.

During 1954-55 the Division's scientists conducted air-sea horizon studies from a Sandy Hook, N. J. lighthouse and made extended flights at 10,000 feet in a light plane to gain information on cosmic rays.

Experiments in the Research Division's low-speed wind tunnel provided the key to a 6 million dollar fume control program for Kaiser's aluminum ore reduction plant in Chalmette, Louisiana. Research physicists studied high-energy underwater explosions in a spark-discharge tank.

In the field of medical engineering, NYU scientists conceived and designed a safety harness to protect air-evacuated patients during crash landings and flights through rough air. A second study in this area involved engineering measurements of the stresses and strains in human bone.

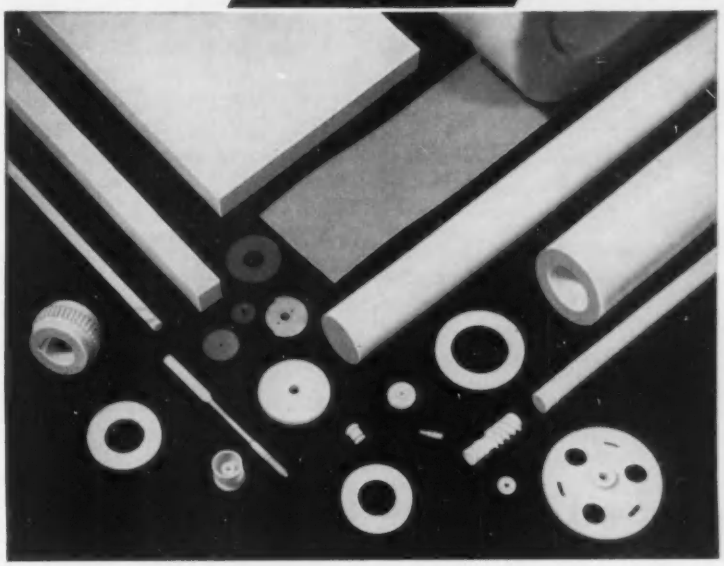
Sanitary engineers devised a system for treating the harmful waste discharge from anchored pleasure craft. This was done for the New York-New Jersey-Connecticut Interstate Sanitation Commission. Another project contributed to a simplified method for detecting nuclear fission product radioactivity in the presence of other radioactive elements.

Research metallurgists continuing an eight-year program on titanium developed two high-strength titanium alloys that can be worked by the cold-rolling method. For United States Steel, Research Division statistical scientists devised means of reducing the volume of experimentation for improved blast furnace production.

Chemical engineers synthesized new fuels for supersonic aircraft, rockets,

(Continued on page 453)

POLYPENCO® NYLON SHAPES



Machine Parts Accurately and at Low Cost from POLYPENCO Shapes

● Simplify your design and production problems right at the start. With high quality POLYPENCO shapes you can fabricate parts at low cost, maintain complete control over production, and change design at a moment's notice.

WHY MACHINING HAS ADVANTAGES

Fabricating from POLYPENCO rod, bar, tubular bar, strip or slab is easily and quickly done on any standard metalworking equipment. Machined parts result in closer tolerances and more uniform dimensions. Moreover, many parts can be produced at high speed on automatic machines.

YOU CONTROL YOUR PRODUCTION

Because nylon parts can be machined from POLYPENCO shapes on conventional metalworking tools in your own shop, direct control over parts production is a simple matter. Production schedules and quality control fall under your direct supervision.

MAINTAIN PRODUCTION SCHEDULES— RAISE UNIFORM QUALITY

You get *all* the desirable properties of nylon in POLYPENCO shapes in piece after piece, order after order. Rigid quality control assures uniform density, dimensional stability, free of porosity and stress spots. This means steadier production and fewer rejects. POLYPENCO Nylon Shapes are stocked in convenient sizes for immediate shipment from warehouses located throughout the country.

For complete data and specifications on POLYPENCO Nylon Shapes write for a copy of the Nylon Bulletin.

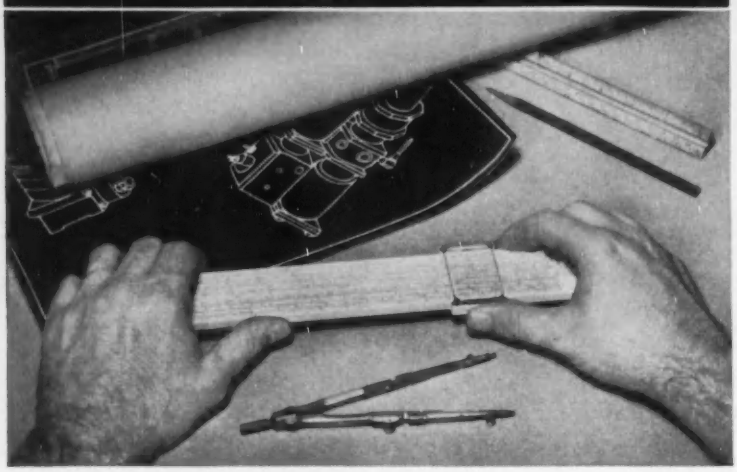
THE POLYMER CORPORATION of Penna. • Reading, Penna.

In Canada: Polypenco, Inc., 2052 St. Catherine W., Montreal, P. Q.

POLYPENCO Nylon, Teflon*, Q-200.5 and K-51

*DU PONT TRADEMARK

FILTER FORUM



Question:

What facts should a product designer determine before choosing a filter?

Success of any pre-planned filter installation is dependent on calculations which are fundamental to the special field of filter design. As a rule, the data is simple to determine. Where unusual conditions exist, Purolator will design special filters to handle them.

Answer:

These five facts: 1. Degree of filtration, 2. Flow rate, 3. Contamination to be removed, 4. Viscosity of fluid, 5. Provision for cleaning or replacement.

1. Degree of filtration of a filter medium means the size of the smallest particles filtered out with 98% efficiency—expressed in microns for sizes less than .001 inch.

2. Flow rate is the flow that a clean filter unit will handle calculated in terms of the fluid's viscosity and the allowable pressure drop through the filter.

3. Contaminants are any elements from water to dust that shouldn't be there—the materials themselves, their quantity, their size.

4. As a rule, the pressure drop through a filter for a given flow rate is proportional to its viscosity.

5. Provision for cleaning or replacement depends on the predicted effects of a temporary lack of filtration while the cleaning or replacement is accomplished. Can the equipment operate temporarily without filtration, for example, can it be shut down periodically – or will two filters be needed; one for cleaning, one for service.

MAIL COUPON FOR DESIGN INFORMATION

PUROLATOR

FIRST in the field of filtering

Dept. D11-429, Purolator Products, Inc., 970 New Brunswick Ave., Rahway, N. J.

Please send me the following filter information:

_____ Purolator's new "Filtration Manual for Designers". I'm enclosing 25¢ to cover postage and handling.

_____ Enclosed is a description of our filter problem. How should we solve it?

NAME _____ TITLE _____

COMPANY _____ ADDRESS _____

CITY _____ ZONE _____ STATE _____

REMEMBER WHEN?

The oil soaked streak down the middle of every road . . . the oil puddle on the garage floor . . . busted shafts and burned bearings due to lost lubrication?

Universal Oil Seals changed that picture . . . solved these problems efficiently and economically. There's a Universal seal to fit YOUR requirements too. Over twenty-six years of specialized oil seal engineering at your service.

We invite your inquiry.

UNIVERSAL OIL SEAL CO.

P.O. BOX 74
PONTIAC 12, MICH.

and guided missiles. In electronic research, the staff worked on two projects involving transistors: one, to simplify circuits at high frequencies; two, to hold down operating transistor temperatures.

Meteorologists experimented with raindrop behavior under electrostatic forces in thunderstorms and obtained new information on the details of lightning formation. They also explored the role of pressure jump lines in the development of dust storms, tornadoes, and squalls.

U. S. Rubber Breaks Ground for Branch and Warehouse

Ground has been broken for a new, modern branch and warehouse for United States Rubber Co. in Stowe Township, Pa. The new facilities, which will be completed in the late fall, will replace present offices and warehouses at two downtown Pittsburgh locations.

J. Chester Ray, administrative head of the tire division of U. S. Rubber, has said that in the decision to expand services to the Tri-State area, U. S. Rubber was acting to strengthen the partnership that has existed with industry since 1906 when the company opened its first Pittsburgh branch.

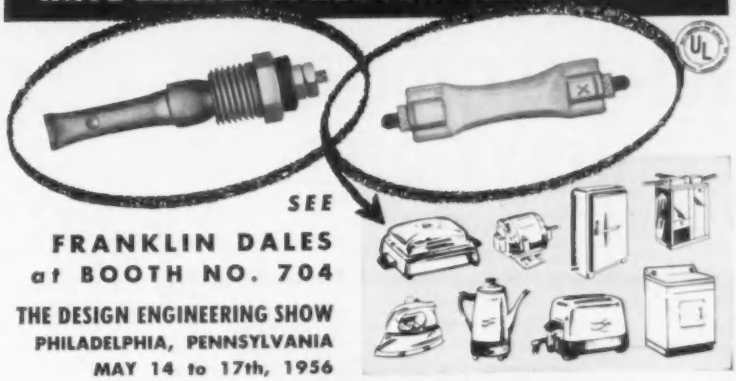
"The growing importance of this area, already the greatest concentration of heavy industry in the country, makes this expansion necessary," said Mr. Ray. "The new branch will become one of the largest headquarters in the company's program of expansion and modernization of its 40 distributing branches. This year the Pittsburgh branch expects a 20 per cent increase in business over 1955. The future for the rubber industry looks bright, with an all-time high of 5¾ billion dollars in sales forecast for 1956.

"Our own company expects its sales to pass the billion-dollar mark for the first time in its history this year. We will spend 36 million dollars in new plants and equipment in 1956, which is about one million more than the previous record amount spent in 1954."

The new larger quarters will provide improved distributing and warehousing facilities for tires, footwear,

(Continued on page 455)

DOES YOUR PRODUCT
REQUIRE DEPENDABLE HEAT CONTROL?
HAVE LIMITED SPACE FOR THERMOSTATS?



SEE
FRANKLIN DALES
at BOOTH NO. 704
THE DESIGN ENGINEERING SHOW
PHILADELPHIA, PENNSYLVANIA
MAY 14 to 17th, 1956

Many years' extensive experience in the design and production of pre-calibrated thermostats is available to you for assistance in the solution of your design problems.

Descriptive Literature, Sample Thermostats Available on Request.

The Franklin Dales Co.
FD "Temp-Guard" THERMOSTATS
180-184 East Mill Street, Akron, Ohio

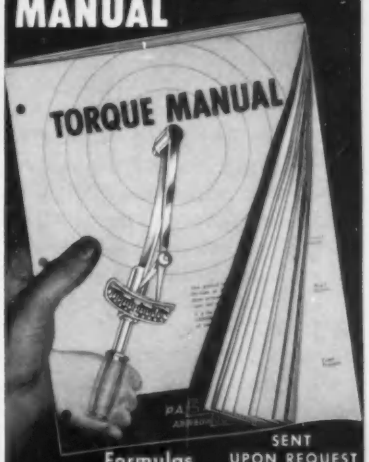
HOMMEL CERAMIC AND CERMET PROTECTIVE COATING

PROTECTIVE COATING FOR METALS SUBJECT TO HIGH TEMPERATURE

- RESEARCH
- DEVELOPMENT
- PRODUCTION

THE O. HOMMEL CO.
PITTSBURGH 30, PA.
"THE WORLD'S MOST COMPLETE CERAMIC SUPPLIER"

"TORQUE WRENCH" MANUAL

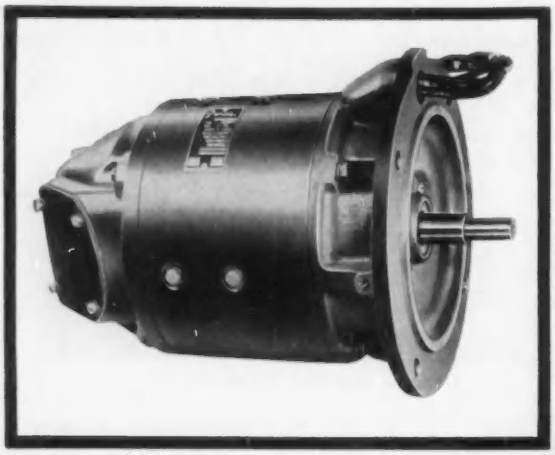


SENT UPON REQUEST

Formulas
Applications
Engineering Data
Screw Torque Data
Adapter Problems
General Principles

P.A. STURTEVANT CO.
ADDISON QUALITY ILLINOIS
Manufacturers of over 85% of the torque wrenches used in industry

Direct Current TORQUE MOTOR PRECISELY POSITIONS HEAVY DIES

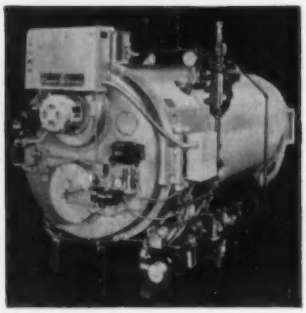


This Peerless direct current torque motor was designed specifically for one of our customers. It operates through a gear unit to smoothly position heavy dies on die-making machinery. An adjustable brush mechanism and rugged construction permit the design to be extremely sensitive and accurate — a necessity for precision die alignment. The motor pictured is one of many DC torque motor designs available at Peerless in the 1/2-3 HP range.

Peerless-customer teamwork made this motor possible. We can apply our motor knowledge to your application in the same way. Let us check your "specs" and give our recommendations. We'll help you select the one motor that powers your product best.

ELECTRIC MOTOR DIVISION
THE *Peerless-Electric*® COMPANY
FANS · BLOWERS · ELECTRIC MOTORS · ELECTRONIC EQUIPMENT
WARREN, OHIO

PROTECTS this BOILER better than any other finish!



Sicon® SILICONE
HEAT RESISTANT FINISH

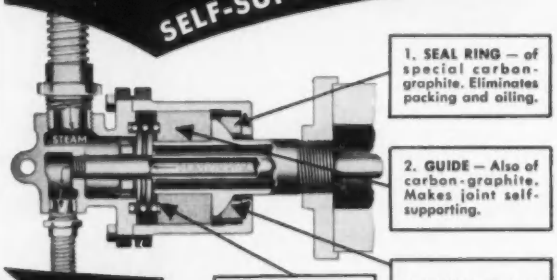
● SICON gray and SICON Maroon are used on all models of the "CB" line of packaged boilers, manufactured by Cleaver-Brooks, Milwaukee. SICON retains its color and gloss in the range of 500° F., far above the hottest skin temperatures of the boiler.

SICON is easy to apply—one sprayed on coat does the job. It dries fast, and protects the surface for the life of the unit. If your product generates sustained heat you need SICON, *the finish that has stood the test of heat and time*. Write today!

MIDLAND *Industrial Finishes Co.*
Dept. D-15, WAUKEGAN, ILLINOIS

ENAMELS
LACQUERS
SYNTHETICS
VARNISHES

JOHNSON Rotary Pressure JOINT
SELF-SUPPORTING TYPE


STEAM
1. SEAL RING — of special carbon-graphite. Eliminates packing and oiling.
2. GUIDE — Also of carbon-graphite. Makes joint self-supporting.
3. NIPPLE — Rotates with roll, seals against ring.
4. SPRING — For initial seating only. In operation joint is pressure sealed.

Only 4 Internal Parts

For introducing steam and liquids into rotating rolls and cylinders, there's nothing like the Johnson Joint above. It's packless, self-lubricating, self-adjusting, self-supporting. It has been adopted by dozens of machinery makers, and is finding new uses every day.

Type SB shown handles both steam and condensate through same head; also available for through flow service, and in sizes and styles for all operating conditions. ***Write for literature.***

The Johnson Corporation
813 Wood St., Three Rivers, Mich.

mechanical goods, electrical wire and cable and hundreds of other products manufactured by the rubber company. The branch will contain 110,600 sq ft and will be located on a five-acre plot at the foot of McKees Rocks bridge. It will consolidate under one roof U.S. Rubber's present branch and warehouses at Sandusky St. and Liberty Ave. The new branch will be a one-story, sand-colored brick structure functional in design and equipped to provide improved shipping and receiving facilities.

Lockheed Missile Facility Will Include Stanford

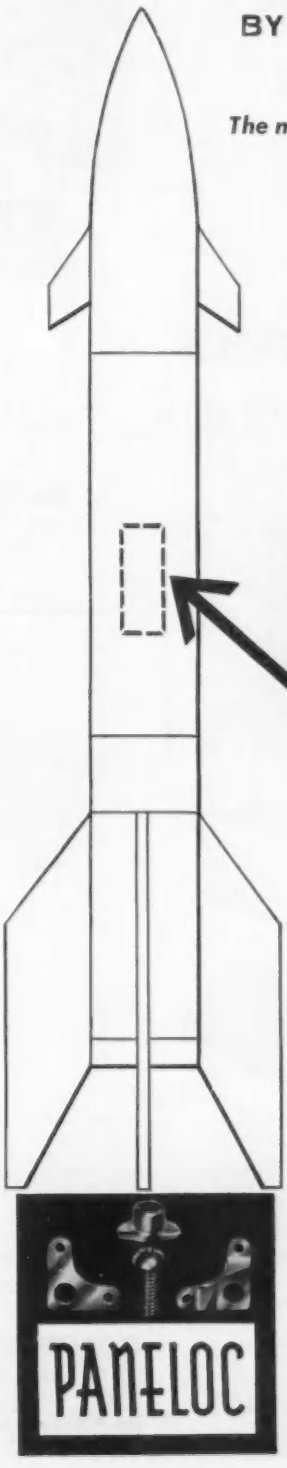
Construction plans have been prepared for a series of research laboratories on a 22-acre site at Stanford University, for advanced scientific studies in the realm of missiles and unmanned aircraft, it has been disclosed by Lockheed Aircraft Corporation and the University. An expanded program by the Lockheed Missile Systems Division, entailing establishment of a new base at Sunnyvale, Calif., was simultaneously announced.

Robert E. Gross, president of Lockheed, said that the new missile division facilities at Stanford and Sunnyvale are first steps in a research and development program calling for a Lockheed investment "of approximately 20 million dollars in the next three years." Gross said about 7 million dollars will be spent on the first two Stanford laboratories and the initial Sunnyvale construction. Additional research laboratories at Stanford and facilities for manufacturing, engineering, and administrative work at Sunnyvale will be built as required by the expanding program.

Dr. Wallace Sterling, Stanford president, said that the missile division's move to the Stanford site will "supplement and strengthen the present program of cooperation between industry and the university of providing new aspects of studies and applications in aerophysics, nuclear physics, specialized electronics, and other areas." Dr. Sterling announced that Lockheed holds a 99-year lease signed this week on part of a new 125-acre tract in the university's industrial park. The technical center near the academic campus now totals 350 acres and includes

(Continued on page 457)

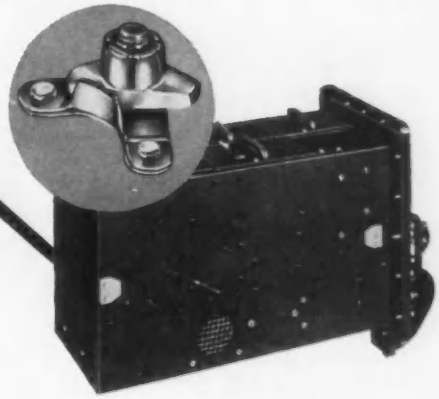
NEW PANELOC
ROTARY LATCH ADVANTAGES LISTED
BY BELL Aircraft CORPORATION



The next 135 words of this advertisement taken from Bell Engineers' letters

S. W. Esmond, Product Engineer:

- Electronic equipment shown was designed to use the PANELOC Rotary Latch at a great saving in space and weight, so vital to the aircraft engineer.
- Rotary Latch assembles to door or panel itself—no stud-to-receptacle line-up problem.
- Tests show no sheet separation—fastener locks with the effect of a nut and bolt assembly.
- Vibration tests also had no effect on the Rotary Latch.



F. P. Bassett, Project Engineer:

- Rotary Latch selected for use on cowl access doors on Bell's latest vertical-rising (VTOL) aircraft.
- The new PANELOC Rotary Latch is excellent for hinged doors and applications where maximum access and opening are important design considerations.
- Its simplicity, vibration resistance, ease of installation and cost are other factors that resulted in Bell's adoption of this new fastener.
- Now in use on fixed-wing aircraft, helicopters, missiles, electronic components.

Write for catalog and price list for your file

A PRODUCT OF SCOVILL
Scovill Manufacturing Company, Aircraft Fastener Div.
49 Mill Street, Waterbury 20, Connecticut

let Stalwart show you how SILICONE RUBBER can cut fabrication costs!

Industry across-the-board is solving problems, and *cutting costs,* with Silicone Rubber Parts. From access door seals on research rocket planes probing the heat barrier . . . to gaskets for kitchen range oven doors, they are providing the answer. Time and again Silicone Rubber Parts are replacing costly metal constructions forced upon design engineers by the limited thermal stability of organic rubbers.

Because new compounds now retain desirable rubber-like properties at temperatures from −130°F. to +600°F., they play ever-increasing roles in the aviation, automotive, electrical and chemical industries.

STALWART is equipped to produce precision parts from a variety of Silicone Stocks to meet individual, S.A.E., MIL-G or MIL-R specifications.

Parts made from Silicone have excellent dielectric properties and resist compression set, weathering, ozone, oxidation, hot lubricating oils and many chemicals. They can be covered with (or bonded to) a number of synthetic or other materials to provide greater strength or wearing qualities. Let STALWART show you how Silicon Rubber can *cut* your fabrication costs.

6851-SR

STALWART RUBBER COMPANY

For complete information, write today for Catalog 56SR-3

MANUFACTURING PLANTS IN BEDFORD, OHIO AND JASPER, GEORGIA
MAIN OFFICES 166 NORTHFIELD ROAD, BEDFORD, OHIO

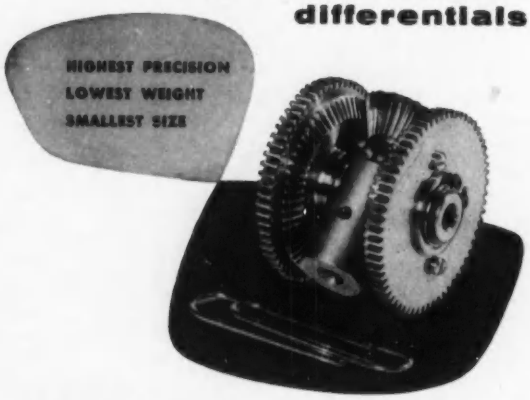
Canadian Aircraft Manufacturer Selects CADDY TOGGLE CLAMPS

AVRO AIRCRAFT LTD. selected CADDY Toggle Clamps because of their long life and rugged construction. Fast action was the second claim. These same qualities are found in the planes built by AVRO.

Send for your FREE '56 Catalog today

CADDY®
Erico Products, Inc.
2070 E. 61st Place • Cleveland 3, Ohio
IN CANADA: ERICO INCORPORATED, 2571 Dundas St., West, Toronto 9, Ontario

PRECISE miniature differentials



Hollow shaft construction permits easy mounting in minimum space. Although extremely small and light, these differential gear units exhibit exceptionally low backlash and friction.

Removable end gears make these units particularly flexible.

Write for technical data.

Backlash less than 0° 7′ standard, and less than 0° 3′ special.

Breakaway torque at zero load: one gear locked —0.007 oz-in. with shaft locked—0.010 oz-in.

End gears interchangeable; supplied in 48, 64, 96 or 120 pitch.

Stainless steel throughout.

Weighs only 0.88 ounce.

Reeves INSTRUMENT CORPORATION

REEVES INSTRUMENT CORP.
A Subsidiary of Dynamics Corp. of America
203 E. 91st St., New York 28, N. Y.

SRV56

among its tenants a number of other electronic and research organizations, including General Electric, Eastman Kodak, and Varian Associates. Lockheed is the only aircraft representative in this community.

Lockheed plans to develop close associations in both education and research with Stanford scientists. Proximity to the University and its laboratories will give Lockheed researchers an opportunity for advanced study; consulting opportunities at the Lockheed laboratories will be afforded the Stanford faculty. Lockheed currently supports a leadership fund for general college scholarships, has a cooperative program for undergraduate engineering students, and the Missile Systems Division sponsors an advanced study program for science students.

Construction will begin immediately on two laboratory buildings at the Stanford site, each of which will occupy 51,000 sq. ft. Building will begin as soon as planning considerations permit on 96,000 sq. ft of manufacturing space at the recently purchased 275-acre site at Sunnyvale, 7 miles from the research laboratories' Stanford location. Missile division personnel are scheduled to start work at the Stanford site this fall and at Sunnyvale by year end.

Lockheed's Missile Systems division was organized two years ago to consolidate the various groups of engineers, scientists, and technicians that had been working on pilotless vehicle projects since the end of World War II. The division in 1954 moved to its present plant in Van Nuys, where it is now engaged in more than a dozen secret projects covering virtually every phase of missile technology.

Automatic Electric To Erect New Factory

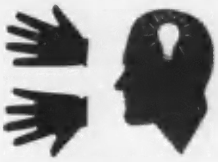
A new, multi-million dollar factory, research laboratory and general office structure will be erected by Automatic Electric Company on a 170-acre site fifteen miles from downtown Chicago. The new facility is expected to cost in excess of 16 million dollars and be completed by late 1957. The overall structure will have about 29 acres of floor space.

Facilities devoted to factory operations will be on one floor, with a

(Continued on page 459)

We have the EQUIPMENT

We have the KNOW-HOW



We have the CRAFTSMEN

to satisfy ALL OF YOUR custom-made

GEAR REQUIREMENTS!

PERKINS MAKES:
to customers' specifications, in all materials, metallic and non-metallic: bevel gears, ratchets, sprockets, ground thread worms, spiral gears, helical gears, spur gears with shaved or ground teeth.

NOTE: The PERKINS PRECISION SPRING COILER is the latest development in the spring coiler field and eliminates entirely the use of arbors and long set-up time. It is a complete self-sufficient machine and enables you to make the spring you want when you want it — in seconds. The coiler produces any type of spring, in any diameter and any pitch with this range: Wire sizes .005 to .125. Diameter, from 3/32" to 12" and larger. Size of the compact coiler is only 7 1/2x16". A POWER MODEL is available. Information on request.

PERKINS MACHINE & GEAR CO.
105 Circuit Ave., WEST SPRINGFIELD, MASSACHUSETTS

ROCKFORD

MEMO
Clutch must maintain it's torque

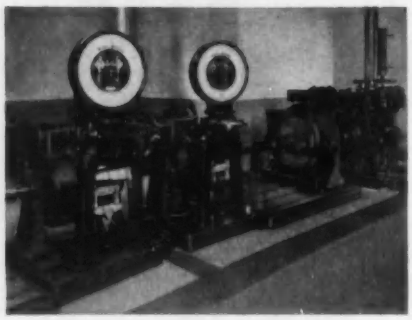
ROCKFORD CLUTCHES, of all types and sizes up to 18", are thoroughly tested for torque capacity — with this powerfull,

PULLMORE

OIL OR DRY

SINGLE OR DOUBLE

MULTIPLE-DISC



accurate Dynamometer. Arranged with an Automatic Cycling Device, this Dynamometer is also used for severe wear testing of facings, linkage, splines, etc. Let ROCKFORD engineers utilize our extensive clutch testing equipment to develop more efficient clutches for *your* products.

ROCKFORD
Clutch Division
BORG-WARNER
209 Catherine St., Rockford, Ill.

Small Spring Loaded

Automotive Spring Loaded

Heavy Duty Spring Loaded

Oil or Dry Multiple Disc

Heavy Duty Over Center

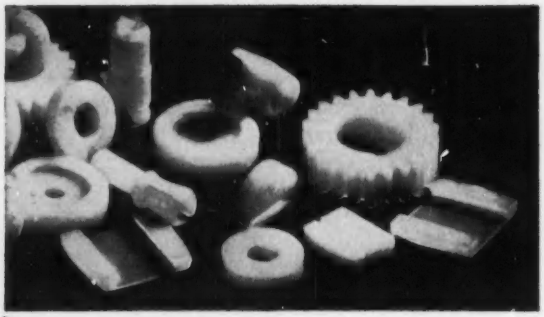
Light Over Center

Power Take-Offs

Speed Reducers

B. W. ENGINEERING MAKES IT WORK
ENGINEERING
B-W
PRODUCTION
B. W. PRODUCTION MAKES IT AVAILABLE

CLUTCHES



See Sinko for
NYLON MOLDINGS

Because we've had many years experience in molding with this tough, shock and wear-resistant material. We have precision-molded countless thousands of fine gears, bushings, washers, skid blocks, rollers, rivets, etc., in our complete and most modern plant.

Sinko also molds all other thermoplastic materials with equal precision and care; and the many leading manufacturers we serve today attest to our ability to accurately produce the most intricate injection molded products, and metal-plastic assemblies

We have facilities for molding parts ranging in size from 4 to 60 oz. . . . be sure to call on us for your needs!

Note: Nylon rivet shown molded for Illinois Tool Works

Sinko MANUFACTURING & TOOL CO.
3135 W. GRAND AVENUE • CHICAGO 22, ILLINOIS

A copy of this quick-reading, 8-page booklet is yours for the asking. It contains many facts on the benefits derived from your business paper and tips on how to read more profitably. Write for the "WHY and HOW booklet."

McGraw-Hill Publishing Company, Room 2710, 330 West 42nd St., New York 36, N.Y.

"straight line" production flow from the receipt of supplies and raw materials to the shipment of the finished product. A railroad siding and truck docks for incoming materials will be located at one end of the building, and all receiving and storing departments will be in this area. The machining department will be located in the next adjacent area, then the stock rooms for temporary storage of manufactured parts and components, followed by the assembly line departments, and finally the packaging and shipping departments. At this end of the building will be another railroad siding and truck docks for the transportation of outgoing products.

Research and development laboratories, and the general, administrative, engineering and sales offices will be housed in an ultra-modern, air-conditioned, two-story building in the front portion of the plant facing east, and will consist of about 7 acres of floor space. When the new factory is completed, the company will be able to consolidate into one facility all of its Chicago operations which are now housed in fourteen different buildings on the near west side.

Automatic Electric began operations over 63 years ago when Almon Brown Strowger, inventor of the dial telephone, and Joseph Harris, a Chicago salesman, formed a company to manufacture telephone equipment. The first automatic system, using push buttons instead of dials was installed at La Porte, Indiana in 1892, followed by the first telephones with dials at Albion, New York in 1896. The Bell System began converting to dial in 1919 with equipment developed and manufactured by Automatic Electric.

The company manufactures telephones, dial switching equipment and other telephone apparatus which it sells to some 5,000 independent telephone companies in the United States and to telephone administrations abroad. It has been estimated that both in the United States and throughout the world, Strowger-type equipment now serves twice as many telephones as any other automatic system.

Other important products manufactured by the company in Chicago are private dial telephone systems, known as P-A-X, which are widely

(Continued on page 461)

get this KEY to lower assembly costs

There are new opportunities for cutting assembly costs in the "Key Locking" feature of KELOX Inserts and Studs. You can improve your product and reduce assembly costs with KELOX because these fasteners—

1. Provide a positive lock between insert or stud and parent body.
2. Provide higher stress allowable per space required.
3. Are simple to install and remove.
4. Make maximum use of tapped hole.
5. Afford considerable reduction in assembly weights.
6. Save space and improve product design.
7. Can be serviced in field without special tools.
8. Require no special threads.

KELOX Fasteners are part of a family of universally used PHILLIPS PRODUCTS that are designed, developed and distributed by a worldwide organization.

This highly specialized, technical group will be glad to assist you with your fastener problems. Use coupon below to get more facts on KELOX!

KELOX

Fasteners, Inc.
580 Fifth Avenue
New York, New York

SALES REPRESENTATIVES—

Universal Fasteners Co.
Centerville Road, P. O. Box 449
Sturgis, Michigan

F. D. Barringer Company
542 Spring Street, N.W.
Atlanta 3, Georgia

Monogram Manufacturing Co.
8557 Higuera Street
Culver City, California

D. R. & W. Technical Service Company
P. O. Box 4
East Hartford, Connecticut

Scott Fittings Limited
339 Bering Ave., P. O. Box 169
Toronto 18, Canada

3385

Please send me technical data on KELOX Inserts and Studs

Name ..... Title .....

Company .....

Address .....

Product being assembled .....

TEFSEAL by SPARTA TEFSEAL

CUSTOM MOLDED

TEFLON

(DU PONT'S TRADEMARK)

IN THIN SECTIONS AND SHAPES

• CUP, BALL, SHAFT SEALS • WASHERS • GASKETS • DIAPHRAGMS

Custom molded parts in TEFLON are better. TEFLON's unique properties . . . chemically inert, heat resistant, tough, flexible, low coefficient of friction . . . offer YOU important advantages in product design and development.

Are you looking for "that" material which can meet your most rigid requirements to resist temperatures ranging from 500° F. to —100° F.? . . . TEFLON is the answer. Are you having trouble with designing your assembly because of corrosive problems? . . . TEFLON is the answer. Let SPARTA's trained engineers help you solve your problems.

TEFLON can save YOU money

- **Less Maintenance**
- **Less Replacement Cost**
- **Increased Productive Capacity Through Less Down-time**
- **Reduced Wear on Pistons, Shafts, etc.**
- **Simplified Design**

The First Cost Can Be the Least . . . If It Is The Last Cost!

Write today for our new brochure
"SPARTA REPORTS ON TEFLON"
Custom Molding in Thin Sections and Shapes.
Dept. PE

SPARTA MANUFACTURING CO.
DOVER, OHIO
Phone: 4-2755

AUTOMATIC CLUTCHES AND TRANSMISSIONS

for Gasoline Engines
Gas Turbine Engines
Electric Motors

Do you have a clutch problem? Since 1936 Salsbury has been solving clutch problems by designing and manufacturing automatic clutches and transmissions for a wide range of applications.

1161 E. Florence Ave.
Los Angeles 1, Calif.

SALSBURY CORPORATION

The Product Design Engineer can always find a complete encyclopedic source of supply for component parts, materials or equipment in—

THOMAS REGISTER

Thomas Publishing Company
461 Eighth Avenue, New York 1

used by railroads, oil and pipeline companies, and large and small industries and businesses of every kind. The company also is a leading manufacturer of relays, switches and other components used in electrical control and the automation of machines and processes.

Dow Corning Increases Silicone Production

Completion of the final unit in a 16-million dollar plant expansion program is reflected by a 7½ per cent reduction in price of dimethyl silicone fluids and emulsions, as announced by Dow Corning Corporation. The new plant facilities will more than double the previous methyl siloxane capacity of Dow Corning, first and world's largest producer of silicones and winner of the 1955 Chemical Engineering Achievement Award.

Effective January 3, the new schedules price-reduced dimethyl silicone fluids and mold lubricants to less than half their original level. The industrial usefulness of these dimethyl silicone fluids was first exhibited in the rubber industry where they have been used almost exclusively since 1946 as release agents for truck and passenger tires. Their next major application, developed by Dow Corning in 1949, was as a polishing agent in car and furniture polishes.

Other applications include damping media, liquid springs, anti-floating agents in paints, liquid dielectrics, and special lubricants for rubber and plastic bushings and gears. Most recently they have been used in artificial lungs and in cosmetic preparations.

Sheffield Corporation Opens Metrology Lab

The Eli Whitney Metrology Laboratory, established by the Sheffield Corporation, Dayton, Ohio, has been officially dedicated. The 250,000-dollar laboratory provides private industry with precise measurement facilities comparable to those of the world's leading government standards laboratories.

The laboratory is equipped for

(Continued on page 463)

Know when Flow is low...
WITH
REVERE FLOW SWITCHES

Know whether liquid flow is safely above required minimum with this Revere flow switch. Only moving part is the float . . . non-absorbent for long-time accuracy. Permanent magnets in float actuate hermetically sealed Glaswitch* at preset minimum rate. Compact . . . low pressure drop. For a range of flow rates and pressures as well as corrosive liquids.

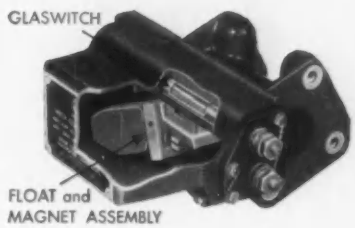
SPECIFICATIONS — F-8290 Flow Switch (typical)
Flow: 1.5 GPM
Weight: 0.70 lb.
Operating Pressure: 70 PSIG
Temperature Range: —65°F to 200°F

Know when a liquid line runs dry...this Revere flow switch flashes a pilot light. Uses a venturi to create differential head during liquid flow to fill float cavity; this causes float and magnet assembly to actuate hermetically sealed Glaswitch*. Air replacing liquid in line drains switch cavity, reversing switch action. Small size . . . low pressure drop.

* Trademark

Ask for Engineering Bulletins 1055 and 1059 describing these Revere Flow Switches. Other types available.

SPECIFICATIONS — F-21110 Flow Switch (typical)
Flow: 3000 PPH minimum
Weight: 1.25 lb.
Operating Pressure: 35 PSIG
Temperature Range: —65°F to 165°F



Revere CORPORATION OF AMERICA 18
WALLINGFORD, CONNECTICUT A Subsidiary of Neptune Meter Company

pip® SELF-LOCKING QUICK-RELEASE PINS

... MAKE AN OPEN AND SHUT CASE OF

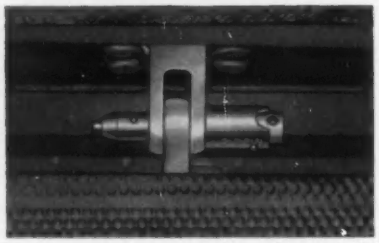
Patented

PIP—Reg. U.S. Pat. Off.

SPEEDING *DOUGLAS* F4D MAINTENANCE!

Fast removal and replacement of ventral access door is accomplished with "B" Series PIP pins. Through quick access, powerplant and systems maintenance time on the Navy's Douglas F4D aircraft is reduced!

This PIP pin application replaces other methods requiring nuts, bolts and cotter pins. Door installation and removal time is fast and simple as PIP pins are easily driven in or out of the fittings and automatically correct for hole misalignment caused by normal structural flexibility. *Safety and ease of use are increased!*



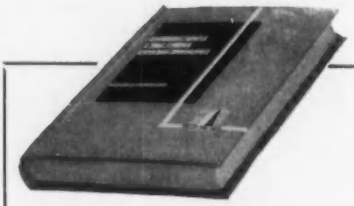
The large powerplant access door utilizes ten "B" Series PIP drive-in, drive-out pins in the hinge-type attachments as shown in photo. Locking is positive and automatic!

PIP pins are available in sizes to most bolt standards and in "T," "L," Ring and Button head styles. For complete information write for Bulletin ADI-5500.

AVIATION DEVELOPMENTS INC.

210 SOUTH VICTORY BOULEVARD, BURBANK, CALIFORNIA

Burbank • Chicago • Denver • Fort Worth • Kansas City • London, England • New York • San Francisco • Seattle • Toronto, Canada • Wichita



ASME HANDBOOK

Engineering Tables

JUST OUT! A reference book making available many tables of recognized design standards not commonly found in handbooks—a wealth of information relating to standards for shape, dimension, gears, and the like. Groups together those tables which apply to design of specific parts. Covers bar stock and shafting, bearings, gears, cylindrical fits, bolts, springs, tubing, electrical motors, and gaskets. **Edited by Jesse Huckert, Prof. of Mech. Engrg., Ohio State Univ. 704 pp., $12.00**

MACHINE DESIGN

JUST OUT! 2nd Ed. Treats design of machine elements and the design and selection of units of power transmission from a practical applications approach. Covers all features of actual design—strength, rigidity, wear and economy of manufacture and operation. Discusses stress concentration, springs, shafts, belt drives, gears, bearings, tolerances, selection of motors, etc. Second Edition gives fuller explanations, wider coverage, brings standards, codes, and practices up to date. **By P. H. Black, Prof. of Mech. Eng., Ohio Univ. 2nd Ed., 471 pp., 392 illus., $7.50**

MECHANISM

JUST OUT! A practical reference for designers and engineers. Analyzes various types of mechanisms and gives an authoritative source of mechanical movements. Discusses gears, cams, drives, linkages, controls, etc., and describes in detail mechanisms for digital and analog computers. Includes a valuable repertory of mechanisms—an illustrated collection of known mechanical movements. **By Joseph Stiles Beggs, Hughes Aircraft Co., and Consultant to U.S.A.F. 418 pp., 444 illus., $6.50**

ENGINEERING in HISTORY

JUST OUT! An absorbing account that shows the development of engineering—how the varying physical and cultural environments since 6000 B.C. conditioned engineering advance and how, in turn, engineering affected other human activities. Emphasizes the history of civil, mechanical, electrical, and metallurgical engineering. Illustrated with contemporary prints, drawings, etc., from many eras. **By Richard Shelton Kirby, Yale Univ., Sidney Withington, formerly with NYNH & H R. R., Arthur Burr Darling, Phillips Academy, and Frederick Gridley Kilgour, Yale Univ., 530 pp., 177 illus., $8.50**

READ THESE BOOKS 10 DAYS FREE

McGraw-Hill Book Co., Dept. PE-4
327 West 41st St., New York 36, N. Y.

Send me book(s) checked below for 10 days' examination on approval. In 10 days I will remit for book(s) I keep, plus few cents for delivery costs, and return unwanted book(s) postpaid. (We pay delivery costs if you remit with this coupon—same return privilege.)

- ☐ Huckert—**ASME Hdbk. Engrg. Tables**—$12.00
- ☐ Black—**Machine Design**—$7.50
- ☐ Beggs—**Mechanism**—$6.50
- ☐ Kirby et al—**Engrg. in History**—$8.50

(Print)
Name .....
Address .....
City .....Zone....State.....
Company .....
Position .....
For price and terms outside U.S. write McGraw-Hill Int'L, N.Y.C. PE-4

measurement certified to an accuracy of one-millionth of an inch and is the only metrology installation in the world in which environmental temperature control is reportedly achieved to an accuracy of 1/20 of 1 deg. F.

The entire floor space of the laboratory (840 sq ft) is structurally independent of the rest of the building in which it is located, being mounted on detached separate footings. The floor base is composed of an 8-inch layer of concrete, upon which rests a 4-inch layer of insulating cork, topped by another layer of concrete surfaced with plastic tile. The eight-inch walls are insulated with glass wool faced with aluminum to provide protection as a heat reflector and vapor barrier. The structural ceiling, 36 inches above the perforated sub-ceiling, is insulated with a 4-inch cork slab. The window, which provides an overall view of the laboratory from the main lobby of the building, is of Thermopane glass.

Within the laboratory is a smaller room which has its own separate temperature controls. This room, which houses the master interferometers used in calibrating master reference blocks to light-wave accuracy, also contains instruments for accurately measuring barometric pressure, another important environmental factor in gage block inspection and measurement.

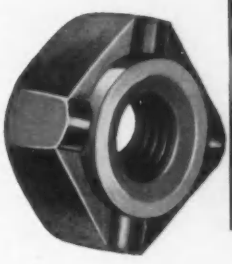
Elaborate and especially designed air conditioning equipment not only holds the temperature to a standard 68 deg F at all times, rapidly compensating for the body heat radiated by people entering the room, but also holds the relative humidity to less than 50 per cent to prevent any surface rusting of expensive and delicate instruments.

In the chamber between the structural ceiling and the sub-ceiling of the lab, air from various sources is blended, cooled and then heated and cleansed by electrostatic precipitation. Without any drafts, this conditioned air enters the laboratory evenly through the perforations of the sub-ceiling. Air within the room is completely changed every five minutes, being exhausted into the air-lock entrance chamber designed to prevent untreated outside air from filtering into the lab.

Measurement and inspection services available to private industry and government at this laboratory include: gage block calibration, parts contour

(Continued on page 465)

SPEED UP THE FABRICATING, FASTENING AND ASSEMBLING OF METAL PARTS WITH



MIDLAND WELDING NUTS!

Midland Welding Nuts may be the answer to your dreams if you're in a business which fabricates, fastens, or assembles metal parts—OR, if you're a designer of products incorporating such parts.

Midland Welding Nuts are welded to the parts to be worked so that bolts can be turned into them speedily—without the need for any device to hold them in place.

They're just the ticket for those hard-to-get-at places. And they stay put—will not work loose or rattle.

Relied on by manufacturers the world over—and specified universally by product designers—Midland Welding Nuts will lower your assembly costs, speed up operations all along the line for you.

Write or phone for complete information!

The MIDLAND STEEL PRODUCTS COMPANY

6660 Mt. Elliott Avenue • Detroit 11, Michigan

Export Department: 38 Pearl St., New York, N. Y.

Manufacturers of

Automobile and Truck Frames • Air and Vacuum Power Brakes

Air and Electro-Pneumatic Door Controls

For Efficiency and Easy Starting it Will Pay You to Specify All 3 of these Fairbanks-Morse Products for your Small Gasoline Engines . . .

Fairbanks, Morse & Co. now offers three essential products for small engines—a flywheel magneto, rewind starter and a centrifugal clutch all designed to fit your engine.

FLYWHEEL MAGNETO

This magneto sets a new standard in both electrical and mechanical life—molded heavy-duty high tension coil—large, long-lasting breaker points—Alnico permanent magnets—easy starting and top efficiency is a certainty.

REWIND STARTER

50% lighter than other types of starters it is ruggedly constructed principally of die-cast aluminum alloy. Instead of meshing gears and pawls the starter mounts over and engages on a regular rope starter pulley. Only ¼ inch of pull is required for engagement. The nylon pull cord will last the lifetime of the equipment. Starting is unbelievably easy.

CENTRIFUGAL CLUTCH

Simple construction with few working parts—tool steel in vital parts. These clutches are resistant to heat and shock and are extremely long lived. One of the toughest applications for a clutch is a chain saw. Approximately 80% of all chain saws are equipped with this clutch. A wide range of engaging speeds is available—springs are adjusted to fit the specific application.

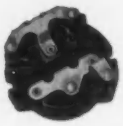
Get all the facts plus application assistance. Write Fairbanks, Morse & Co., Magneto Division, Beloit, Wisconsin.

FAIRBANKS-MORSE

a name worth remembering when you want the best

MOTORS • ZC ENGINE • MAGNETOS • STARTERS • CLUTCHES • PUMPS • DIESELS

The Finest Electrical Contacts AT THE LOWEST QUANTITY PRICE



AUTOMOBILE SWITCH

APPLIANCE TIMER

D. E. Makepeace, over 50 years a leader in the bonding of precious metals to base metals, offers to the electrical industry a line of quality contacts at mass produced prices for exceptional economy. The raised lay and spot lay contacts illustrated are typical for scores of special applications produced to rigid specifications. We'd like to help you design for outstanding performance with remarkable economy.

SPOT LAY®

RAISED LAY

Makepeace

D. E. MAKEPEACE COMPANY
Division of
Union Plate and Wire Co.
Attleboro, Mass.

ENGELHARD INDUSTRIES

From Tomatoes to Toys

You'll Find MEYERCORD Decal Nameplates

on almost everything . . .

Use Meyercord Decals to Identify—Instruct—Advertise

Meyercord Decals on tomatoes? Yes, we make specially engineered Meyercord Nameplate Decals by the *millions* for every manner of product . . . from edibles to hard goods. You'll find Meyercord Decals giving added realism and interest to children's toys . . . from baby things to electric trains and games for the teenager. You'll find Meyercord Nameplate Decals on jet plane engines, withstanding tremendous heat . . . and on jet fuel lines, withstanding the inroads of powerful solvents. You'll find Meyercord Decal Nameplates on the panels of armed forces electronic equipment subjected to every climatic condition. Write us about your nameplate and marking problems . . . we promise you a surprise.

The Meyercord "Mark It" Decal Nameplate Manual is yours without cost or obligation . . . write for it on your company letterhead—today.

THE MEYERCORD CO.

World's Largest Decalcomania Manufacturers

DEPT. R-318, 5323 WEST LAKE STREET • CHICAGO 44, ILLINOIS

measurement, surface finish analysis, plain and taper plug and ring gage calibration, measurement of cylindrically ground parts, master setting gage calibration, surface plate and parts flatness calibration, thread gage calibration, calibration of thread and gear measuring wires, measurement of precision threaded parts, hardness testing, end measure calibration, calibration of precision circles and fiber fineness measurement. Consulting services for the establishment of industrial metrology facilities, training and educational services in precision measurement and product dimensional audit services are offered by the new laboratory. The master instrument for light wave comparison measurement is the Zeiss Koesters Absolute Interferometer, which uses light sources of either helium, krypton, cadmium or the mercury 198 isotope.

Electronics Plant Planned by Ramo-Wooldridge

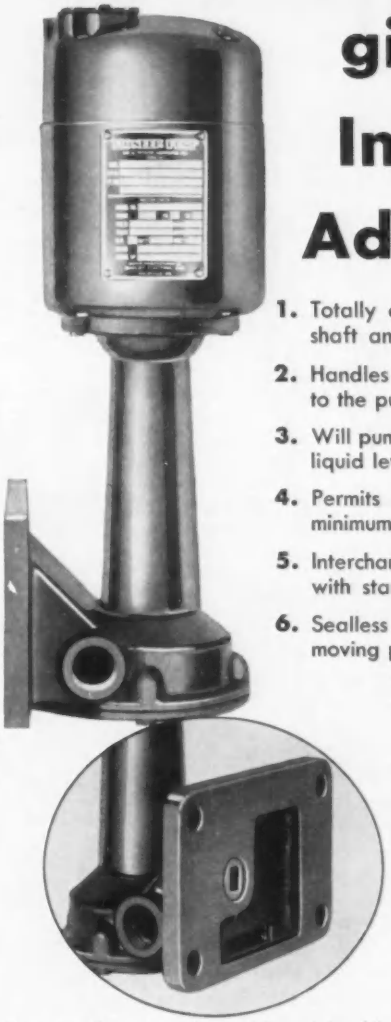
Plans for the erection of a major electronics manufacturing plant have been announced by Dr. Dean E. Wooldridge, president of The Ramo-Wooldridge Corporation of Los Angeles. The west coast firm has exercised an option on 640 acres of industrial land near Littleton, southeast of Denver. Ground will be broken in May or June on the first structure of 172,000 sq ft, with construction to allow for future expansion.

Original production in the new factory will be electronic systems for military customers, such as fire control systems for aircraft, radar systems, electronic computers, or advanced communications equipment. Later, the company expects to produce automation and data processing equipment for commercial clients.

Dr. Wooldridge said that, because of the government's dispersal policy for major weapons systems suppliers, an early decision was made that The Ramo-Wooldridge manufacturing plant would not be on the west coast. Denver was selected because of its convenient proximity to Los Angeles by air, an important factor in company liaison. Also, a survey revealed that engineering and scientific people employed by the company generally ap-

(Continued on page 467)

This New PIONEER Coolant Pump gives you Important Advantages



1. Totally enclosed motor, with extra-heavy shaft and heavy-duty ball bearings.
2. Handles abrasives or chips without injury to the pump.
3. Will pump down to 1 1/16"; self-priming to 1" liquid level.
4. Permits clean-out of machine sump with minimum time and labor.
5. Interchangeable with any make pump with standard mounting dimensions.
6. Sealless design with no metal-to-metal moving parts.
7. Can be furnished with any desired electrical characteristics.
8. Three optional outlets: left external, right external, center outlet through mounting flange. The latter permits compact, clean-cut design of machine with no exposed piping.

Pioneer offers more than 400 models of impeller-type and positive displacement pumps to meet every coolant pump requirement; or we will develop designs for specific applications. Our application engineers will welcome the opportunity to discuss your pump requirements with you.

Send for our illustrated booklet covering the basic Pioneer designs in both impeller-type and positive displacement pumps.

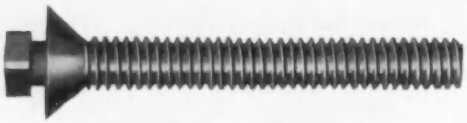
PIONEER PUMP DIVISION
DETROIT HARVESTER COMPANY
Sales Office: 5450 West Jefferson Ave., Detroit 9, Michigan
Plant: Paris, Kentucky

"ELCO SCREWS ARE GOOD SCREWS

ELCO

...ASK A MAN WHO HAS USED THEM"

COLD-HEADED "SPECIALS"



"PRISON SCREWS"

If the title "prison screw" seems strange to you, the explanation is that the extended driver head breaks off when the screw is driven home — thus discouraging removal. The other "specials" illustrate a variety of the forming operations available at ELCO — heading, necking, serrating, thickening, flanging, chamfering, roll threading, and many others. ELCO facilities also include an Engineering Service that will help you design — or re-design — your special screws and similar pieces for *lowest-cost* manufacture. *Always consult your ELCO representative.*

ELCO PRODUCTS

WOOD SCREWS
MACHINE SCREWS
MACHINE SCREW NUTS
TAPPING SCREWS
THREAD-CUTTING SCREWS
PHILLIPS AND SEMS SCREWS
PIPE PLUGS
STOVE BOLTS
CAP SCREWS
LAG SCREWS
DRIVE SCREWS
SPECIAL SCREWS
COLD HEADED PRODUCTS

ELCO TOOL AND SCREW CORPORATION

1958 BROADWAY, ROCKFORD, ILLINOIS

New MARCO TYPE Y5 SHADED POLE MOTOR

1/25 to 1/4 h.p.

- Higher Efficiency
- Better Stability
- Cooler Operation

LOW in COST

• This new, large diameter (5-1/2"), more powerful motor has all the features of the famous Marco Motors used in hundreds of thousands of air conditioning units — in fans, blowers and furnaces.

Power up to 1/4 h.p. can be supplied — or — in the new "wafer thin" design (as short as 2-1/2 inches) 1/15th horsepower.

Get the facts on this motor today!

MARCO INDUSTRIES, INC.

7th and Franklin Streets • Womelsdorf, Pa.

Get Greater Accuracy In Your Stamped Gears

EACH WINZELER STAMPED GEAR, in runs of hundreds or *thousands*, equals or surpasses the most exacting specifications. They invariably cut assembly time, and costs. Mechanisms run smoother, sweeter, longer. And users like the quiet, dependable performance of WINZELER Geared products. Send along drawings, specifications, quantities needed. Let our capable staff help you.

SEND FOR *useful 4-page folder . . a valuable Stamped Gear guide. Gives technical data, tables, ideas, suggestions, descriptions of many types. Use company stationery please!*

WINZELER MANUFACTURING & TOOL CO.

1712 WEST ARCADE PLACE, CHICAGO 12, ILLINOIS

prove of Denver as a place to live and work.

The architectural firm of Pereira and Luckman of Los Angeles has designed a fully integrated modern one-story manufacturing facility which will include machine shops, a sheet metal shop, metal process facilities, extensive electronic and mechanical assembly lines, environmental test and inspection facilities, store-rooms, and office space for production engineering, research and development liaison personnel, and administrative offices.

The Ramo-Wooldridge Corporation was organized in the fall of 1953 around a central group of scientists, engineers and science administrators, some of them nationally famous in their fields. Of the present staff, one-third is composed of professional personnel, and of this group one-third are Ph.D.'s while another third hold master's degrees. The emphasis in the corporation is on systems having a high content of scientific and engineering newness.

The company has the advantage of a strong financial position, is backed by Thompson Products, Inc., auto and aircraft parts manufacturer of Cleveland, Ohio. Buildings currently occupied or under construction by Ramo-Wooldridge in the Los Angeles International Airport area total 300,000 sq ft. Employment has grown from 150 in July, 1954, to nearly 1400 currently. By December, 1956 employment is expected to exceed 2300. Sales this year are expected to exceed 20 million dollars.

Motorola Facilities at Phoenix to be Enlarged

Motorola, Inc. has announced 3 million dollar plant expansion plans for its Phoenix, Ariz., research and production facilities. The new plant site is on 160 acres, 2 miles southeast of Scottsdale, resort center about 9 miles west of Phoenix. The additional 150,000 sq ft of production and laboratory space will bring total plant space of Motorola's three Phoenix facilities to 300,000 sq ft.

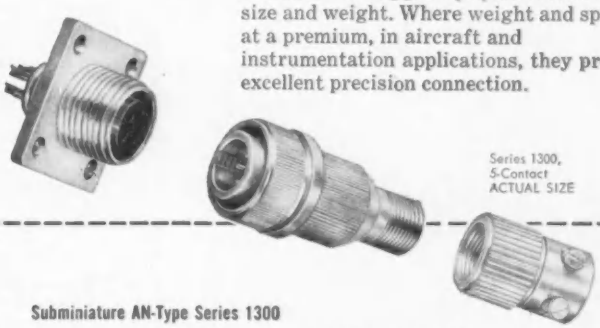
Work in the new plant will be devoted to research, development, and production of military electronic equipment. This plant will parallel production of one of the two other

(Continued on page 469)

PRECISION
Continental Connectors

Solve space and weight problems with Continental subminiature electrical connectors

Continental Connectors are pace-setters in subminiaturization to meet increasing demands for rugged equipment of small size and weight. Where weight and space are at a premium, in aircraft and instrumentation applications, they provide excellent precision connection.



Series 1300, 5-Contact ACTUAL SIZE

Subminiature AN-Type Series 1300

Precision-machined aluminum shells meet military requirements for salt-spray test resistance. One-piece molded inserts prevent moisture traps and electrical breakdowns possible with conventional AN two-piece inserts. Floating contacts guarantee self-alignment of each contact and reduce engagement and disengagement to a minimum. Inserts are permanently swaged into shell to form a single cartridge unit. Current Rating: 7.5 amps. Contacts take #20 AWG wire. Two shell sizes are available: one for 3, 4, and 5 contacts; the second for 15, 19, 27, and 31 contacts.

Series SM-20, 7 Contacts (Shown with * Polarizing Screwlocks) ACTUAL SIZE

Subminiature Rectangular Series SM-20

Contacts are phosphor bronze, gold plated over silver for low contact resistance and soldering ease. Floating contacts assure positive alignment of each contact. .040 diameter contacts eliminate assembly difficulties encountered when soldering sub-standard wires. Polarizing screwlocks (See photo) and other contact arrangements are also available in this series. Rating: 5 amps. Contacts take #20 AWG wire.

* Pat. Pend.

Series G-20, 2 Contacts ACTUAL SIZE

Subminiature Rectangular Series G-20

Ideal for the small spaces. Molding has hole for convenient, space-saving side mounting. Precision-machined sockets of spring temper phosphor bronze and pin contacts of brass are gold-plated over silver for lowest contact resistance and easy assembly soldering. Connectors are available in 2, 3, and 4 contacts with a variety of pin arrangements, with or without hood and cable clamp.

Technical data on these connectors, and special designs requiring the use of subminiature, hermetic seal, pressurized, high voltage, or power connectors, are available on request. Write today for complete catalog.

Electronic Sales Division
DeJUR-Amsco Corporation,
45-01 Northern Boulevard, Long Island City 1, N. Y.
DeJUR

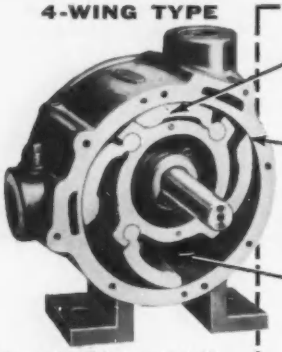
Exclusive Features of

LEIMAN Rotary Air and VACUUM PUMPS

bring you

★ High Vacuum ★ Smaller Size
★ Greater Volume ★ Lifetime Operation

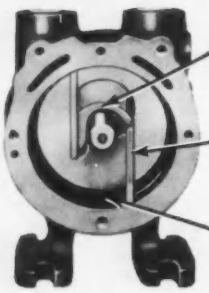
4-WING TYPE



- Curved Wings on easy-action hinge, maintain continuous wall contact.
- Cast Iron Wings and Cylinders hone themselves to hard, glassy smoothness—take up their own wear—assure leak-proof seal for years.
- Extra-large Air Space provides greater capacity, permits use of smaller pump.

Vacuums to 20" Hg.; pressures to 15 psig.; displacement to 162 c.f.m.

2-WING TYPE



- Automatic Wing Adjuster assures wing-to-wall contact, prevents sticking, guarantees positive action.
- Extra-long Steel Wings (not composition) provide long wear. Cylinder walls made of durable cast iron.
- Large air space provides more compact pump.

Vacuums to 29.9" Hg.; pressures to 20 psig.; displacement to 40.8 c.f.m.

Install LEIMAN AIR PUMPS

for dependable Vacuum (Suction) and Pressure

FREE ENGINEERING DATA

- *Application Book* showing 60 "how-to-do-it" blueprints of actual applications.
- *16-page Catalog* showing construction, types, sizes, capacities, etc.

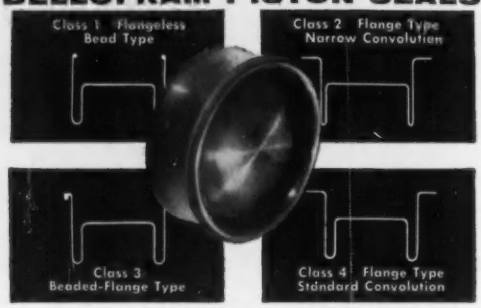
SEE OUR CATALOG IN SWEETS FILE

Precision-made, compact Leiman Air Pumps have fewer moving parts — no tips or blades to renew — need no maintenance except occasional oiling — run for 10, 15 and 20 years without trouble or shutdown. Over half a million installed. Consult our engineers on any air application.

LEIMAN BROS., Inc.

107 Christie St., Newark 5, New Jersey

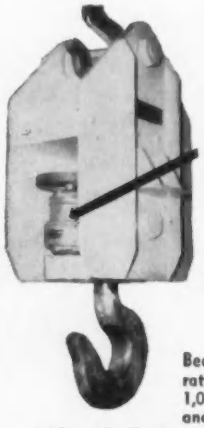
NOW THERE ARE 4 TYPES OF BELLOFRAM PISTON SEALS


Class 1 Flangeless Bead Type
Class 2 Flange Type Narrow Convolution
Class 3 Beaded-Flange Type
Class 4 Flange Type Standard Convolution

Bellofram long stroke, constant area diaphragms are now available in *four* designs, for efficient use as piston seals in countless types of pressure-sealed mechanisms. Class 1 permits design and manufacture of smaller, lighter, lower cost mechanisms. Class 2 is specially suited to high pressure applications and limited to sizes under 2½". Class 3 allows parting surfaces at flange joint to form a metal to metal joint. Class 4 is suitable for instruments and machines having natural parting surfaces between cylinder and mating metal surfaces.
Bellofram seals are available in any of 300 standard sizes; for 1" to 6" bores; in numerous elastomer-fabric combinations from Nitrile Rubber and Nylon to Silicone Rubber and Dacron. Choice is wide, design and operating advantages many. Outline your needs in confidence.

Have you a copy of the NEW 16-page Bellofram Catalog? Write today.

Bellofram
CORPORATION
BURLINGTON, MASS.



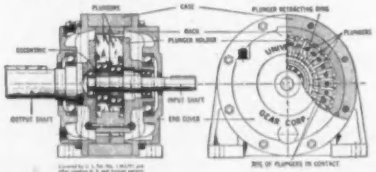
40 Tons Controlled with a *Feather Touch*

in the new Heppenstall Rotating Crane Hook

By a

UNIVERSAL Heliocentric SPEED REDUCER*

Because it gives higher torque and wider ratio range in minimum space; 20:1 to 1,000,000 ratios. Compact Design. Balanced Load Action. . . Two complete assemblies distribute power for unsurpassed smoothness. Low Cost, Trouble-Free Operation. Only two principal moving parts. Little or no maintenance.



For your requirements, write or call IV 2-1346 for complete information.

*Trademark registered

UNIVERSAL GEAR DIVISION
NOVO PUMP AND ENGINE CO.
702 Porter Street Lansing, Michigan

Motorola divisions in Phoenix. The company's third plant produces transistors for military and civilian use.

When completed, the new facility will employ a work force of 1,000—divided into about 400 engineers and physicists and about 600 assembly and production workers. Motorola now employs 2,000 at its two other Phoenix facilities. When all three plants are in production, the company payroll will top 1.5 million dollars a month, making it one of the largest in the state.

Following Motorola's practice of integrating an industrial facility into residential districts, the company will build an attractive architectural building set in park-like grounds. One of the Motorola facilities at Phoenix is adjacent to an exclusive country club and is surrounded by 25,000 dollars —and upwards—homes. And in Arizona—where the construction dollar buys 2-1 to 3-1 in comparison with midwest and eastern building money —a 25,000 dollar home is in the mansion class.

Soreng Products and A-P Controls Merge

Louis Putze, President of Soreng Products Corporation, Schiller Park, Illinois, and Roy W. Johnson, President of A-P Controls Corporation, Milwaukee, Wisconsin, have jointly announced merger of their two companies to form Controls Corporation of America. The two companies had combined 1955 sales of about 25 million dollars. The new corporation will be headed by Louis Putze as President, and Roy W. Johnson as Chairman of the Board. Each company will retain its individual identity, continuing operation as a Division.

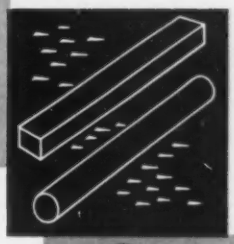
The diversified product line resulting from the merger makes possible fuller service to the home laundry, home heating, commercial refrigeration, air conditioning, and automotive industries. Manufacturing facilities comprise eight plants in the United States, Canada, and Europe, with a total floor space of more than 500,000 sq ft. Coordinated purchasing of common components and material, together with centralization of specific processes wherever possible, promise economies in manufacturing.

Greater diversification and more

(Continued on page 471)

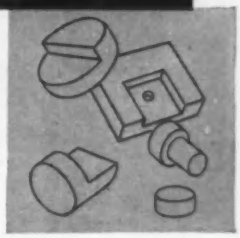
MECHANICAL SHAFT SEALS

New Stackpole oil seals greatly reduce pitting, blistering, spalling. Many other types for use with air, gases, corrosive chemicals and other liquids.



MAXIMUM SALT BATH RECTIFICATION

Stackpole Carbon Rods in electric salt bath furnaces avoid decarburization. Heating is fast and uniform. "Drag out" is minimized, electrode life increased.



RESISTANCE WELDING *and* BRAZING TIPS

. . . that last 3 to 4 times as long.

Stackpole "F" treatment minimizes oxidation, reduces dressing by ⅓, assures longer life.

STACKPOLE

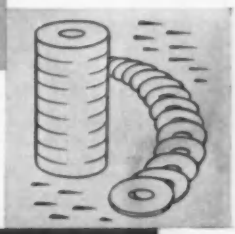
CARBON-GRAPHITE

materials and components

Boost Efficiency • Reduce Costs

POROUS CARBON *that is 75% AIR*

A typical example of carbon versatility, this new Stackpole material has many potential uses as filters, etc. Has high electrical conductivity and high resistance to chemical attack. Is stable at high temperatures.



FOR CRITICAL VOLTAGE CONTROL

Stackpole Carbon Discs (piles) offer maximum control efficiency as pressure-sensitive resistance elements over a broad range of critical voltage control work. Write for catalog.

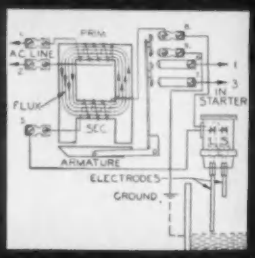
EASY SOLUTIONS TO MOLD *and* DIE PROBLEMS

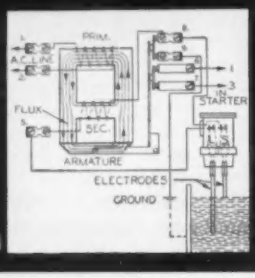
Carbon molds and dies are readily formed or machined. Extremely high heat capacity plus ability to maintain strength at elevated temperatures makes them ideal for foundry, glass molding, powder metallurgy and other uses.

STACKPOLE CARBON COMPANY • *St. Marys, Pa.*

OTHER STACKPOLE PRODUCTS INCLUDE: BRUSHES for all rotating electrical equipment • carbon-graphite and metal powder ELECTRICAL CONTACTS CHEMICAL ANODES • CATHODIC PROTECTION GROUND RODS • BRAZING BOATS and TRAYS • BEARINGS • TUBE ANODES • FRICTION SEGMENTS • CLUTCH RINGS • PUMP VANES • WELDING CARBONS • RESISTANCE WELDING and BRAZING TIPS • SPECTROGRAPHITE • ELECTRIC FURNACE HEATING ELEMENTS • WATER HEATER and PASTEURIZATION ELECTRODES . . . and many more.

LIQUID LEVEL CONTROL
with the
B/W RELAY





Type LH Relay
for
Pump Down Control

POSITIVE AND DEPENDABLE

The B/W system of liquid level control consists of a transformer type induction relay and a holder for one or two electrodes, depending on the desired operation and the type of relay used. The relay incorporates a primary or line voltage coil connected to a permanent source of alternating current, and a secondary or electrode circuit coil connected to the electrodes immersed in the liquid being controlled. Energizing the primary coil causes an induced voltage in the secondary coil; thus the secondary coil is never connected to the power line.

LIQUID IS ELECTRICAL CONDUCTOR

The liquid itself is the electrical conductor that completes the secondary circuit. When this secondary circuit is completed, by the liquid contacting both electrodes, the magnetic attraction set up in the legs of the relay core causes the armature to close, and open or close the load contacts. A built-in holding circuit maintains this contact until a predetermined fall in liquid level breaks the circuit. By adjusting the electrode settings, the range of operation can be controlled.

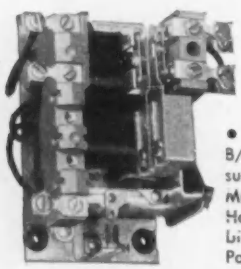
FOR PUMP UP and PUMP DOWN APPLICATIONS, SIGNALS and ALARMS

B/W relays are designed for either pump up or pump down operation. In addition, by using a single electrode they are well suited for signal and alarm applications.

NO MOVING PARTS

The complete absence of moving parts in the liquid insures long and trouble-free performance. Because of the very low current in the secondary circuit these relays are ideal for many switching jobs outside of the liquid level field.

Consult our engineering department on any special control applications.



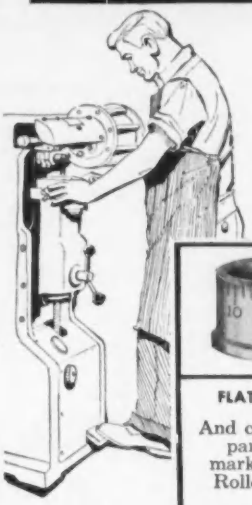
CATALOG on request

- It covers the complete line of B/W Induction Relays, Enclosures, Contactors and Starters, Multiple Pump Controls, Electrode Holders, Starter and Relay Combinations, Special Controls and Panels.

B/W CONTROLLER CORPORATION
2218 E. Maple Road, Birmingham, Mich.

FIRST IN THE FLOATLESS CONTROL FIELD

PRODUCTION MARKING



Speed your production with a GENERAL PURPOSE MARKING MACHINE. Several models available for quick, safe, light or heavy-duty marking of round, flat, or contoured parts, at rates up to 800 per hour!

ROUND PARTS
Held in Cradle Rolls, are marked with Flat-Roll Dies.

FLAT PARTS
And contoured parts are marked with Roller Dies.

Write for Bulletin FGP-200

JAS. H. MATTHEWS & CO.
3956 FORBES ST. PITTSBURGH 13, PA.
BOSTON • CHICAGO • PHILADELPHIA • CLIFTON, N. J.

IF THIS IS YOUR PROBLEM

If you need effective, highly readable, smartly illustrated company literature (booklets, pamphlets, manuals) to display your products, inform the public of your operations, attract key personnel to your plant, train employees, and perform any of the other communicative functions that are vital to your business . . .

THIS IS YOUR ANSWER

The McGraw-Hill TECHNICAL WRITING SERVICE has a staff of more than 150 highly-trained writers, editors, and illustration specialists whose job it is to create technical and general literature for industry. We write, illustrate, design, and print Equipment Manuals, Product Bulletins, Handbooks, Company Histories, Annual Reports, and other specialized material. Save money and time. Let our staff be your staff for Technical and Business publications.

This service is available through ad agencies.

Write • Phone

TECHNICAL WRITING SERVICE
McGraw-Hill Book Co., Inc.
330 W. 42nd St., N. Y. 36, N. Y.
LOngacre 4-3000

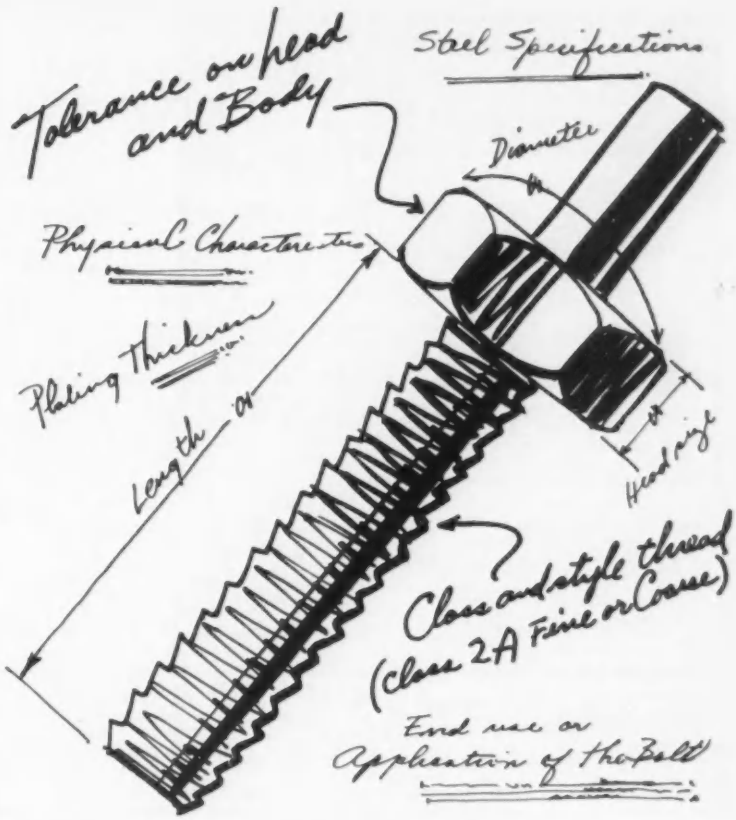
efficient engineering will be available through the integration of the research and engineering facilities of both companies. The combined staff of these two control manufacturers, totaling more than 150 product and development engineers, reportedly will provide one of the better engineering services in the controls industry.

Soreng Products Corporation in business over 30 years is a supplier of components for the home laundry, refrigeration, air conditioning, automotive, and home appliance industries. This division operates three manufacturing plants. Its engineering department specializes in the research, design, and development of solenoids, manual and automatic switches, automatic timers, automatic gas controls, shaded pole motors, and other electrical components. In the field of ultra-precision products, Soreng manufactures solenoid-operated valves for jet aircraft and guided missiles.

For more than 25 years, A-P Controls Corporation has been specializing in the design and manufacture of room thermostats, vaporizing oil burner controls, refrigeration controls, and similar items. At present, A-P controls is the largest manufacturer of constant-level valves for vaporizing oil heaters and furnaces and is a large producer of expansion valves and other controls for the refrigeration and air conditioning industries. Most recently, this division has developed and introduced a new type of integrated gas control for the gas heater and furnace industry.

Design Show Schedule In Next Issue

As an aid to our readers attending the First Design Engineering Show, the May issue of *Product Engineering* will contain a floor plan of Philadelphia's Convention Hall showing the numbered booths, and a list of the Show's exhibitors. Close to 200 companies will be represented at the Show. In addition, there will be a detailed time schedule for the Show and the technical sessions, as well as the names of the speakers. The Design Engineering Show will run from May 14 to 17.



FROM A SKETCH

as rough as this...

Special fasteners that improved product design and function at reduced cost have often been engineered from ideas sketched on a pad. At Buffalo Bolt, experienced fastener designers welcome the opportunity of engineering your roughs into practical designs to do your intended job. Equally important, our production men know just how to produce them to meet your schedules.

Of course, we are always ready to quote on finished designs for specials, too.

EITHER WAY, you can be sure of fast, experienced cooperation when you call in Buffalo Bolt.

BUFFALO BOLT COMPANY
Division of Buffalo-Eclipse Corporation
NORTH TONAWANDA, N. Y.

● *3 convenient service centers*

WESTERN OFFICE	EASTERN OFFICE	CENTRAL OFFICE
Chicago	New York City	North Tonawanda
HArrison 7-2179	REctor 2-1888	JAckson 2400 (Buffalo)

Many **GOOD** *products can be made* **BETTER** *...with* **SPECIAL FASTENERS**

SEARCHLIGHT SECTION
(Classified Advertising)

BUSINESS OPPORTUNITIES

EQUIPMENT - USED or RESALE

Direct Factory Representatives

PLEXIGLAS • LUCITE
NYLON • TEFLON • ACETATE
STYRON • VINYL

SHEETS
RODS
TUBES

Write for catalog

ACTIVE PLASTICS CORP.
277-279 Franklin Avenue ● Floral Park
Franklin Square, L. I., N. Y. 2-8928-9

WANTED TO BUY
USED RECENT MODEL
TENSILE TESTING MACHINE
EITHER 60,000 100,000 or
200,000 LB. CAPACITY
W-8878, Product Engineering
330 W. 42 St., New York 36, N. Y.

PROFESSIONAL SERVICES

DESIGN ASSOCIATES
Tool Designing Available
Jigs, Fixtures, Progressive and Compound Dies
Layout and Detailing Service
2432 N. Charles St. Baltimore 18, Md.

GEORGE H. KENDALL
Consulting Mechanical Engineers
Methods Studies: Process or Product
Redesign Existing Products for Greater Profit,
Trouble Shooting Production, Design, Cost Problems,
Specialist Automatic Machinery, Process, Controls,
New Developments, Patent Studies, Investigations,
New Products & Process Engineering Studies
P. O. Box 3 (*Est.* 1923) Tel. Darien 5-1504
Noroton Heights 3 Offices Darien, Connecticut

WILLARD F. MASON
Consulting Electrical Engineers
Precision Electromechanical Designs
Specialist Slip Ring Assemblies—All Applications
Engineering Administration, Cost Systems
Product Development Programs
Manufacturing Facilities
186 Post Road, Darien, Conn. Oliver 5-9039

NATIONAL COVERAGE

EMPLOYMENT OPPORTUNITIES

DISPLAYED RATES UNDISPLAYED

The advertising rate is $23.20 per inch for all advertising appearing on other than a contract basis.

An Advertising inch is measured ⅞" vertically on a column—3 columns—30 inches to a page.

Subject to Agency Commission.

$1.80 per line, minimum 3 lines.

Box Numbers—counts as 1 line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

Not subject to Agency Commission.

Send ..W ADS to PRODUCT ENGINEERING, 330 W. 42nd St., N. Y. 36, N. Y., for May issue closing April 15th

MECHANICAL ENGINEERS AND DESIGNERS

With several years' experience in heavy machine design for work on electro-hydraulic cranes, steel hatch covers, and other marine cargo handling equipment.

WE ARE NEWLY LOCATED IN CENTRAL PHILADELPHIA

Join an old, established company in a new division with wonderful opportunities for advancement. Excellent salaries and benefits. We pay interview and relocation expenses.

Replies Confidential. Write or wire —

Mr. K. E. EYLER
MACGREGOR-COMARAIN DIVISION
NATIONAL-U. S. RADIATOR CORP.
1420 WALNUT ST. PHILADELPHIA 2, PA.

CONVEYOR DESIGNERS

Conveyor Designers capable of squad supervision. Opportunity with leading conveyor manufacturer. Must be willing to re-locate. Write complete details of experience and Salary expected. This information will be kept strictly confidential.

THE ALVEY-FERGUSON COMPANY
DEPARTMENT EB
CINCINNATI 9, OHIO

ASST. CHIEF ENGINEER

You will direct R. & D. activities of small group of practical, hard hitting engineers. Fractional horsepower motor division of manufacturer electric rotating equipment. Co. has 4 plants, consistently operates profitably. Starting salary $12,000 plus liberal bonus. Employer pays agency fee and relocating expense.

MONARCH PERSONNEL 28 E. Jackson Blvd. Chicago 4, Illinois

CHIEF ENGINEER

$9,000 to $14,000 a year. With creative ability to head up development group on new product design. Experience in appliances preferred. Know all phases of design, process, manufacture, etc. Send complete resume to:

J. J. COOPER
64 E. Jackson Blvd. Suite 940
Chicago, Ill. WAbash 2-1918
Prompt and confidential service.

MECHANICAL ENGINEERS

We need four engineers, preferably with design experience; one is required for steam turbines, one for steam turbine controls, one for centrifugal pumps and one for centrifugal compressors. Design experience is desirable but not absolutely necessary; young engineers interested in these fields, but without specific experience, will be carefully trained. De Laval is a medium sized, long established manufacturing concern. The positions are for our permanent engineering staff. Starting salary and progress will be commensurate with ability. Please submit brief resume of qualifications to:

Personnel Department

De Laval Steam Turbine Company
853 Nottingham Way
Trenton 2, New Jersey

IMAGINEER

Would you like to be a free-lance inventor with a regular salary?

Dream your own dreams of invention, then develop and perfect them with the assistance of a 120-men Engineering Division and a staff of Patent Attorneys.

No time card, no written reports, just the responsibility of creating and developing ideas. All this plus extra bonuses for patents, patent applications, and promising ideas.

A leading electrical appliance manufacturer located in the middle west needs new ideas and is willing to provide just such a setting for a young engineer with creative ability.

The man being sought preferably is under 40 and has several patents or patent applications to his credit. If you can qualify for such a position and are interested, please submit a brief resume together with a photograph to

P-1046, Product Engineering
520 N. Michigan Ave., Chicago 11, Ill.

Position wanted in
*** * * NEW PRODUCTS DIVISION * * ***

of Progressive Firm actively engaged in design, developing and marketing new electrical, electromechanical and electronic products. Experience: 6½ yrs college, 5 yrs industrial, 3 yrs teaching, patent history. Salary $8500-$11500, advancement based upon results.

PW-1185, Product Engineering
330 W. 42 St., New York 36, N. Y.

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42nd St. (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITIONS VACANT

Industrial Designers a progressive, midwestern manufacturing concern needs an industrial designer and stylist with considerable experience and creative ability. Knowledge of merchandising techniques helpful. He must be capable of handling commercial consumer products. This is a newly created position in an important product development program. A good opportunity for a qualified man. Salary is open. Please send complete resume to P-9343, Product Engineering.

POSITION WANTED

Electrical design engineer with design and development experience and several years' experience as a practicing patent attorney wishes to obtain lucrative employment adjacent to or around New York City. Write PW-9504, Product Engineering.

OPENINGS at CROSLEY AND BENDIX

CROSLEY Electric Ranges, Freezers, Air Conditioners and Refrigerators are famous the world over. So is the BENDX Duomatic all-in-one washer-dryer.

The Engineers we prefer should have 1 to 3 years' experience in the appliance or associated fields. They will work directly with the Project Engineer and have important responsibilities in the following areas:

1. *Design and development of new products and components.*
2. *Practical and functional applications of new and present products and their components.*

Our advanced development programs call for Senior Engineers who have vision and ability. Salaries are in keeping with the positions.

Please send us a written resume or contact our Director of Engineering at once.

CROSLEY AND BENDIX
Home Appliances Divisions
AVCO
MANUFACTURING CORPORATION
Dept. 20
1329 Arlington Street
Cincinnati 25, Ohio
Kirby 1-6600

Fort Wayne, Ind.
"America's Happiest City"

Dear Bill:

Now that Joe is on the team here at Farnsworth, he's asked me to write and give you the same story that got him interested in coming with us.

Actually, Bill, it wasn't a "story." Just a few honest-to-goodness reasons why he and Marge should make the move and let the family really live as well as let Joe grow professionally.

For instance, do you know what "sold" Marge? The fact that in living here you are only 10 minutes from everywhere—schools, churches, stores etc. and Joe goes home for lunch every day instead of week-ends. She also liked the idea of some 300 lakes within 70 miles. (Guess where they're planning to spend the summer!)

As for Joe, he's all hepped up about the work he's doing on such missiles as Bomarc, Talos, Terrier and others. Says the top-notch scientists and engineers he's working with are all big-league and he's on the team.

That's about it, Bill. An engineer with your talents shouldn't be waiting around when he can get in on the ground floor here at Farnsworth in research, development or production engineering in missile guidance and control, radar, microwaves, test equipment, countermeasures, transistor applications etc.

So—why not write, right now to Don Dionne, Farnsworth Electronics Co. Fort Wayne, Ind. (A division of International Telephone and Telegraph Corp.)

You, Joe, I and Farnsworth will be mighty glad you did.

Sincerely, Jack

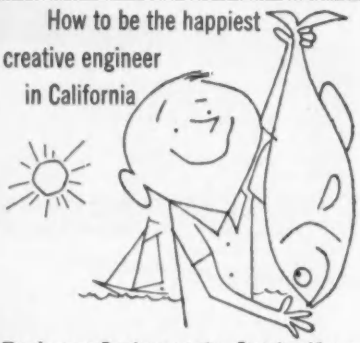
Machine Designers Draftsmen

• Promotions within our company have created a number of opportunities for qualified men to grow with our growing engineering organization.

If you'd like a career with a real future, with a long established company that's widely known as a good place to work, write or visit us now!

Write: C. T. Blake, Mgr.
Engineering Department

WARNER & SWASEY CO.
5701 Carnegie Avenue • Cleveland 3, Ohio



Beckman Instruments, Inc.* offers E.E.'s, M.E.'s, Manufacturing, and Sales Engineers the kinds of jobs that creative men dream about. Top salary, all employment "extras" including our Educational Assistance Plan, modern facilities and personal recognition that comes naturally with our decentralized operation. Small town living...but near metropolitan areas in either Fullerton, So. Pasadena, Newport Beach, Richmond or Palo Alto.

*We're pacing the commercial electronics field ($3,000,000 sales in 1949 to $21,000,000 sales in 1955) and we'll be disappointed if you don't grow with us.

Beckman / *instruments, inc.*

Write Beckman Instruments, Inc., 2999 W. 6th St., Los Angeles 5, Calif. Ask for Career File # 58

DESIGN ENGINEERS

Graduate Electrical, Mechanical, or Chemical Engineers for project design in plant engineering group. Diversified application of engineering. Positions available at Junior through Senior levels. Complete program of employee benefits including moving expenses and education refund program.

For prompt and complete information, address resume of education and experience to Employment Supervisor.

NATIONAL LEAD COMPANY
CONTRACT OF OHIO OPERATOR
Feed Atomic Energy Commission Project
P.O. BOX 158 MT. HEALTHY STA. CINCINNATI 31, OHIO

ADVERTISING MAN WANTED FOR TECHNICAL PRODUCTS

Previous advertising experience not necessary but helpful. Must have at least two or three years of college with courses in engineering and technical subjects and like to write. If you have the qualifications we have an opportunity open for you. Man selected will be trained in all phases of industrial advertising. In your letter of application state age, education, positions held, and give statement of why you want a career in advertising. Location: well-known Connecticut company.

P-1211, Product Engineering
330 W. 42 St., New York 36, N. Y.

DESIGN ENGINEER

Excellent opportunity for a really creative engineer willing to grow into administrative responsibilities. Inventiveness and the ability to be truly objective are the keys to a successful career with a progressive organization having the largest Research and Engineering facilities in the steel valve industry.

EDWARD VALVES, INC.
Subsidiary of Rockwell Manufacturing Company
East Chicago, Indiana

MECHANICAL ENGINEERS

Immediate openings in fast-growing field of

SEMICONDUCTORS

Permanent career positions with General Electric in Syracuse, New York . . . for development and design of automatic machinery for the manufacture of transistors and rectifiers.

Unusual opportunity for mechanical engineers with B.S. or M.S. degrees and experience in machine design.

Chance to work with the industry's leading engineers . . . under ideal working conditions in modern laboratories, fully equipped with all facilities.

To learn more about your G-E opportunity to live and work in the heart of New York's vacation land, write today to:

Mr. M. D. Chilcote,
Department 1-86-PE

Electronics Park
Syracuse, New York

GENERAL ELECTRIC

ENGINEERS

Electronic *Mechanical*

There's room to...

GROW

AT MELPAR

Currently we seek men with experience in one or more of the following:

- Network Theory
- Systems Evaluations
- Microwave Technique
- UHF, VHF, or SHF Receivers
- Analog Computers
- Magnetic Tape Handling
- Digital Computers
- Radar and Countermeasures
- Packaging Electronic Equipment
- Pulse Circuitry
- Microwave Filters
- Flight Simulators
- Servomechanisms
- Subminiaturization
- Electro-Mechanical Design
- Small Mechanisms
- Quality Control and Test Engineers

More and more these days you hear top engineers talk about the many growth opportunities at Melpar. With an increasing number of significant electronic projects, an enlarged staff and facilities, Melpar provides many opportunities for professional growth and advancement. Our new laboratory is an engineer's dream come true; a building conceived by and constructed for the ENGINEER – 265,000 sq. ft. of complete engineering facilities.

We are located in Fairfax County of northern Virginia where housing is reasonable and plentiful—whether you desire a private home or an apartment. Although we are in a truly suburban atmosphere, we are only 10 miles from the nation's capital with all its recreational and social advantages. Here you and your family can grow in an environment to match your professional growth.

Send resume to Technical Personnel Representative,

melpar, inc.
A subsidiary of the Westinghouse Air Brake Co.

3000 Arlington Blvd., Dept. PE-28, Falls Church, Va.
11 Galen Street, Watertown, Mass. • 99 First St., Cambridge, Mass.

ENGINEERS

The APPLIED PHYSICS LABORATORY of THE JOHNS HOPKINS UNIVERSITY offers an exceptional opportunity for professional advancement in a well-established Laboratory with a reputation for the encouragement of individual responsibility and self-direction.

Our program of

GUIDED MISSILE RESEARCH and DEVELOPMENT

provides such an opportunity for men qualified to design:

GUIDANCE, HOMING, AND CONTROL CIRCUITS
ANTENNAS
MICROWAVE COMPONENTS
COMPUTERS
THE EXTERNAL AERODYNAMICS OF MISSILES
RAMJETS
MISSILE STRUCTURES
LAUNCHERS
DATA-RECORDING AND PROCESSING EQUIPMENT

Please send your resume to Professional Staff Appointments

APPLIED PHYSICS LABORATORY
THE JOHNS HOPKINS UNIVERSITY
8641 Georgia Avenue
Silver Spring, Maryland

PRODUCT DESIGN ENGINEERS

With experience in:

- **Packaging of electronics components**
- **Cooling techniques for electronic equipment**
- **Human Engineering**

At Raytheon's new Wayland Laboratory Mechanical and Electrical Engineers work together as a team to create the custom designed equipment which has enhanced Raytheon's reputation for

"Excellence in Electronics".

The recent expansion of our engineering facilities makes it possible to offer unusual opportunities to experienced creative engineers.

Beginning salary range $6000 to $10,000.

A brief resume form and a brochure describing this new laboratory may be obtained by writing Mr. Robert E. Doherty.

RAYTHEON MANUFACTURING COMPANY
WAYLAND LABORATORY WAYLAND, MASS.

RAYTHEON

- **Full tuition paid for accepted educational programs.**
- **Location convenient for country or city living.**
- **Progressive salary review system.**
- **Liberal employee benefit program.**

HUGHES
FALCON

Research and Development at Tucson

The Hughes Research and Development Laboratories have now been extended to Tucson, Arizona, where the deadly air-to-air Falcon is presently being produced for the U.S. Air Force and Canadian continental defense interceptors.

This is in line with a long-range program that includes application of the Hughes Falcon to more and more types of military aircraft.

ENGINEERS
PHYSICISTS

New positions are being created in fields of specialization covering the complete range of structural, hydraulic, electronic, and electromechanical engineering. Experimental, analytical, or design abilities will be required of those who work in these areas.

Scientific Staff Relations

HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES

TUCSON, ARIZONA

Index of PRODUCTS ADVERTISED

In This Issue

•

A

Accumulators 121

Actuators
- Electrical 290-291
- Mechanical 117, 402

Adhesives 115, 259-264

Aluminum Alloys 24-25, 92, 97, 309-312, 351, 406

Aluminum Coated Sheet and Strip (see Steel, Coated)

Amplifiers 478

Assemblies
- Electrical 408, 488
- Hydraulic 273
- Pneumatic 268-269, 273

B

Balls 276

Bars
- Metal 10, 24-25, 56, 118, 128, 351, 375
- Non-Metallic 451

Bearing Materials 104, 118

Bearings
- Ball 50, 89, 96, 134, 235, 245, 276, 282-283, 332, 385, 415, 434, 448
- Miniature 134
- Needle 96, 245
- Oil-less 118, 224, 363
- Roller 15, 26-27, 50, 89, 96, 233, 245, 271, 282-283, 415
- Self-Lubricating 118, 375, 410
- Sleeve 118, 224, 331, 353, 363

Bellows 379

Belt Lacers 485

Belts 32, 38-39, 86-87, 427

Blowers 442

Bolts..74, 266, 270, 346, 394, 432, 466, 471

Books 460, 462

Boosters 121

Boots .....2nd Cover

Brakes
- Hydraulic 226
- Mechanical 226

Brass 81, 92

Bronze 92, 315, 410

Brush Holders 488

Brushes, Electrical 488

Bushings 331, 375, 410

Bushings, Strain Relief..... 436

Index of

PRODUCTS ADVERTISED

In This Issue

•

C

Cable 42-43

Cameras (See Photographic Equipment)

Cams 449

Carbon 429, 440, 469

Carbon Parts 363, 440, 469

Casters 407

Castings 20-21, 320, 477

Castings, Precision Investment..356, 437

Ceramics 287, 354

Chains
- Conveyor 13, 339-340
- Roller 13, 279, 339-340 370, 430
- Silent 13, 279, 339-340

Chemical Treatments 8, 246, 254, 414

Clamps 456

Clamps, Hose 338

Clips, Electrical 422

Clutches
- Hydraulic 460
- Mechanical 265, 279, 387, 458, 464

Coatings ...8, 115, 246, 254, 259-264, 414 453, 454

Coils 2, 57

Cold Headed Parts 394, 466

Collector Rings 488

Compressors 301

Computers 478

Conduit 92

Connectors
- Electrical 63, 303, 337, 436, 467
- Hose 273, 280, 389
- Tube 273, 280, 389

Contactors 22-23, 373-374

Contacts & Contact
- Materials 4, 31, 304, 464
- Control Panels & Switchboards 22-23, 101-102, 373-374

Controls
- Electrical 22-23, 64-65, 101-102 112, 251, 373-374, 425, 470, 478
- Electronic 22-23, 101-102, 470
- Hydraulic 277, 391, 420, 445
- Mechanical 350, 445
- Pneumatic 277, 391, 411

Conveyors 413

Copper & Copper Alloys...56, 84, 92, 406

Cords 42-43, 409

Cork Compositions 272

Counters 17, 251

Couplings
- Hose 273, 389
- Hydraulic 389, 399, 438
- Mechanical 279, 387, 399, 446
- Tube 389

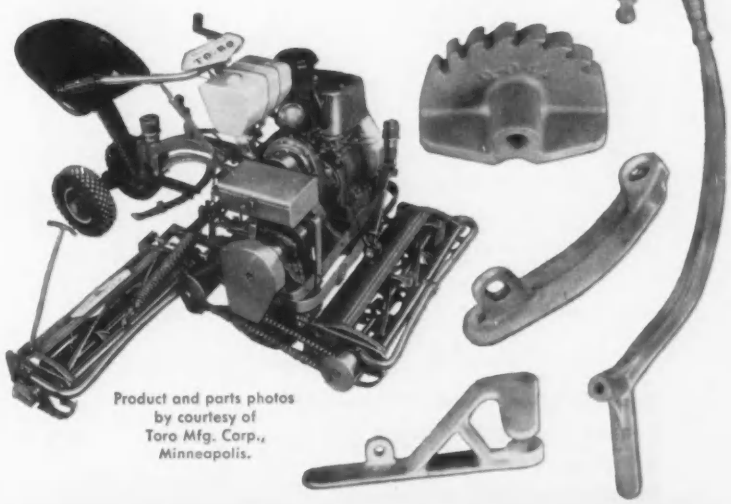
Continued on p. 478

How About Malleable?

For tough service in heavy duty equipment, prominent manufacturer chooses malleable iron

Products that must be rugged and durable — like the important lawn maintenance machine below — are "naturals" for the application of malleable iron castings. This is an example of using malleable for a number of its advantages — sturdiness, uniformity, machinability, economy and appearance.

It pays you to find out how malleable foundry engineers can help you with ideas for cost-reducing and better design. Write to Malleable Founders' Society for copies of "Malleable Iron Facts" and name of your nearest malleable foundry.



Product and parts photos by courtesy of Toro Mfg. Corp., Minneapolis.

Malleable FOUNDERS' SOCIETY

1800 Union Commerce Building Cleveland 14, Ohio

AFFILIATE OF GENERAL CERAMICS CORPORATION

Magnetic Amplifiers · INC

—announces its new

VARIABLE SPEED DRIVE

MAGNE-SPEED*

SIZE II —
3/4, 1 and 1-1/2 HP

SIZE I —
1/4, 1/3 and 1/2 HP

Stepless, instant starting, compact, 50:1 speed range, good regulation without tachometer, long life, virtually maintenance free service, low cost, fast response, reversibility, dynamic brake, local or remote control. Write for Bulletin S580-5-55.

Other MA Products and Services

Magnetic Servo Amplifiers
Transi-Mag * Amplifiers
Analog Computors
Photoelectric Controls
DC and AC Regulated Power Supplies

* Trade Name

Application engineering and conversion of tool machines and production processes to automatic control.

Magnetic Amplifiers • Inc
Tel. CYpress 2-6610 • 632 TINTON AVE., NEW YORK 55, N. Y.

Index of PRODUCTS ADVERTISED

In This Issue

•

Continued from p. 477

Cylinders
Hydraulic 109, 121, 277, 326
Pneumatic 121, 277, 326, 411

D

Decalcomanias 464
Deep Drawing 289
Diaphragms .....2nd Cover
Die Castings...316, 322-323, 324, 404, 484
Dies 296
Differentials 308, 456
Drafting
Machines 85, 338
Supplies 85, 338
Drives
Adjustable Speed 90-91
Hydraulic 292-293
Right-Angle 410
Timing 284
Variable Speed.....3rd Cover, 32, 51
72-73, 325, 327, 344, 478
Dynamometers 458

E

Electrical & Electronic Components, Custom Made (see also Production Services) 383, 467
Enamel 398, 454
Engine Indicators & Controls...448, 464
Engineering Services (see also Production Services)...63, 75, 119, 130, 302
Engines 119, 317, 396, 417, 441
Expanded Metals 345
Expansion Joints 60
Extrusions
Metallic 56, 92, 97, 343, 351, 434
Non-Metallic 318, 428, 435, 451, 456

F

Fabricated Plastics (See Plastics, Fabricated)
Fabricated Steel (see Structural Forms & Shapes)
Fabrics, Coated 93
Facings, Clutch 427
Fastening Methods 109, 132, 349
430, 459
Felt 381, 438
Fibre 336, 342, 376, 442
Fibre Glass 480
Filters
Air 268-269, 446, 452
Hydraulic 378, 386, 446, 452

Index of

PRODUCTS ADVERTISED

In This Issue

•

Finishing Equipment & Supplies..... 414
Flexible Couplings 387, 399
Flexible Shafts 237
Forgings 351
Friction Materials....38-39, 272, 424, 427
Furniture, Engineering Dept. 69

G

Gaskets .....2nd Cover, 38-39, 71, 106 392, 442
Gear Motors (see also Motor Reducers)..51, 275, 344
Gears 1, 37, 72-73, 255, 285, 347 424, 433, 457, 466
Generators
A-C 124-125, 430
D-C 124-125, 430
High Frequency 124-125
Glass 355
Glass Parts 403
Graphite 469

H

Heat Exchangers 107, 412
Heating Units 108, 308
Hermetic Seals 367
Hermetic Sealing Service..... 78
High Temperature Alloys.....36B, 88
Honing Machines 358
Hose & Tubing.....38-93, 239, 273, 389
Hydraulic Fluids 257

I

Inspection Equipment 250
Instruments Mechanical 372
Insulation 103, 342, 423, 450, 480
Insulators 287, 297

L

Lacquer 454
Laminated Plastics (see Plastics, Laminated)
Latches 455
Leather .....2nd Cover
Liquid Level Controls..... 470
Low Temperature Melting Alloys.... 444
Lubricants 432
Lubricating Equipment.....45, 99 247 268-269

Continued on p. 480

If you're suffering from tired metals, weak metals, corroded metals—or some other costly metal ailment—it will pay you well to put in a call to a metals specialist today. May we suggest Riverside? Our metallurgists *are* specialists. And Riverside's experience in non-ferrous alloys spans more than a century. Experience, incidentally, that is yours for the asking.

THE RIVERSIDE METAL COMPANY DIVISION
H. K. PORTER COMPANY, INC.
Riverside, New Jersey
Philadelphia • East Orange, N. J. • Rochester, N. Y.
Hartford • Cleveland • Chicago • Detroit

RIVERSIDE HKP

PHOSPHOR BRONZE AND NICKEL SILVER SHEET, STRIP, WIRE AND ROD

We Cracked the TIME BARRIER!

with DPS

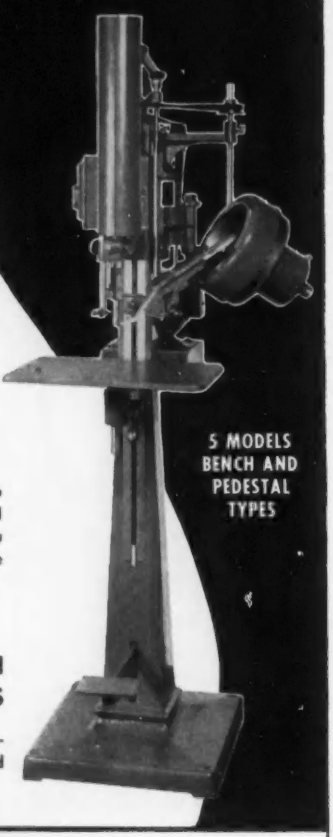
MODERN POWER METHODS!

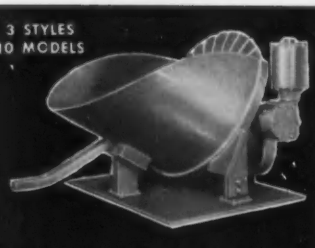
No need for PRODUCTION DRAG on these assembling and feeding jobs!

When you can combine greatly stepped-up output with reduced costs, quality control and uniform results, it adds up to benefits you can't afford to ignore. Advantages that are emphasized by the use of

DPS POWER SCREWDRIVERS and SELECTIVE PARTS FEEDERS

And remember, D.P.S. specially trained engineers are ready to tackle your problem and come up with the right answer.





Shown are two products from our expanded up-to-the-minute line. Get the story. Write for catalog and full details.

DETROIT POWER SCREWDRIVER CO.

2821-A W. FORT ST. DETROIT 16, MICH.

Index of PRODUCTS ADVERTISED

In This Issue

•

Continued from p. 479

M

Magnesium Alloys 434
Magnetic Materials 295
Magnetos 464
Magnets 295, 416
Marking Machines & Tools..... 470
Metal, Pre-finished 406
Molybdenum Alloys 104
Motor Reducers
(see also Gear Motors)..... 37
Motor Starters 22-23, 48, 101-102
Motors, A-C
Fractional..3rd Cover, 16, 48, 51, 76-77 90- 91, 110-111, 124-125, 275, 286 302, 357, 362, 400, 430, 442, 454, 466
Integral..3rd Cover, 46, 48, 51, 58-59 76-77, 90-91, 110-111, 124-125, 286 302, 343, 348, 357, 362, 400, 430 442, 454
Sub-Fractional.....90-91, 110-111, 275 360, 444
Motors, Air 301
Motors, D-C
Fractional..16, 51, 76-77, 90-91, 110-111 124-125, 275, 286, 298-299, 302, 357 400, 430, 466
Integral..46, 51, 58-59, 76-77, 90-91 110-111, 124-125, 286, 298-299, 302 343, 348, 357, 400, 430
Sub-Fractional.....90-91, 110-111, 275 298-299, 444
Motors, Hydraulic 292-293, 420

N

Name Plates 464
Nickel Alloys 36B, 70
Nickel Silver 479
Nuts..14, 28-29, 41, 66, 74, 109, 132, 270 401, 422, 432, 436, 442, 450, 466, 471

O

Oils 257

P

Packings ...38-39, 257, 334, 392, 426, 448
Paper 79
Phosphor Bronze 2, 479
Pillow Blocks 89, 282-283
Pins 47, 462
Pipe 97, 351
Plastic Film 49

Index of

PRODUCTS ADVERTISED

In This Issue

•

Plastic Parts.....130, 318, 365, 383 388, 451, 458, 460
Plastics 18-19, 38-39, 388, 451
Plastics Fabricated 388, 451
Plastics Laminated.297, 336, 342, 365, 388
Plates 10
Plugs 303
Plywood 276
Porcelain 403
Potentiometers 313
Powdered Metal Parts..4th Cover, 38-39 113, 118, 224, 316, 331, 375
Power Packs
Hydraulic 277
Power Take-offs 458
Precious Metal Alloys..... 304
Production Machines & Processes... 368
Production Services (see also Engineering Services) ...359, 383, 408, 457 480, 489
Pulleys 86-87, 256
Pumps
Air 301, 446, 468
Liquid 292-293, 324, 420, 433 438, 446, 465, 481
Vacuum 301, 446, 468

R

Rams 438
Ratchets 457
Recorders 100, 278
Regulators
Pneumatic 268-269
Relays ..22-23, 64-65, 112, 222, 243, 307 390, 438, 470, 482, 486
Release Agents 103
Reproduction Equipment 85
Reproduction Supplies 85
Resins 18-19, 294, 425, 443
Resistors 22-23, 40
Resolvers 308
Retaining Rings 61
Revolving Joints 454
Rheostats 22-23
Rivets 14, 109, 270
Rod Ends 50
Rods
Metallic 24-25, 56, 315, 351, 479
Non-Metallic 451
Rolls 103
Rotating Couplings 75

Continued on p. 482

PROVIDES THE *PUSH*

BEHIND THE PUSH BUTTONS

Photos courtesy Herring-Hall-Marvin Safe Company, Hamilton, Ohio

TUTHILL MODEL OOL

Powers Electro-Hydraulic Control On Automatic Vault Doors

In step with today's automatic age, this unique bank vault door operates by push-button control. To power the electro-hydraulic mechanism that controls this automatic opening and closing operation as well as lowering and raising the foot bridge, H-H-M engineers selected the Tuthill Model OOL, known the world over for its dependable performance.

The dependability so essential for applications like this is engineered into the Tuthill Model OOL. Vertical ports maintain its prime. The mechanical seal contributes to quiet, leak-free performance and low power consumption. Precision manufacture assures constant delivery of capacity required. And as a final guarantee of performance, every Tuthill unit is subjected to the most exhaustive tests before shipment—to make them extra safe for safe service.

TUTHILL PUMP COMPANY

Dependable Rotary Pumps ... since 1927

939 East 95th Street
Chicago 19, Illinois

Write today for complete data on Tuthill pumps for hydraulic service.

Canadian Affiliate: Ingersoll Machine & Tool Co., Ltd. Ingersoll, Ontario, Canada

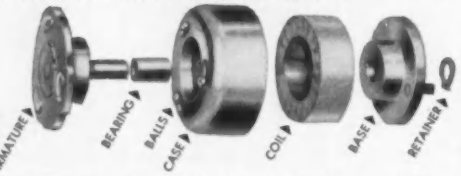
LEDEX ROTARY SOLENOIDS

GIVE POSITIVE, POWERFUL SNAP-ACTION!

Here's how a LEDEX ROTARY SOLENOID operates . . .

The magnetic pull moves the armature along the Solenoid axis. This action is efficiently converted into a rotary motion by means of ball bearings on inclined races. The inclined ball races are made to compensate for the magnetic pull increase as the Solenoid air gap closes, thereby providing substantially equal starting and ending torque during the rotary stroke. The rotary snap-action power of the Ledex can be efficiently harnessed with a minimum of linkages, through the use of one or more standard features available on all models.

Here's why LEDEX ROTARY SOLENOIDS are dependable!



As can be seen from the exploded view, Ledex Rotary Solenoids are simply constructed with few moving parts. All parts are manufactured to exacting tolerances and are carefully inspected and assembled. The copper wire coil, the heart of the Solenoid, was developed especially for this product. It is wound by a precision winding process that puts a maximum amount of magnet wire into available space . . . giving tremendous power to compact Ledex Rotary Solenoids.

Basic sizes of LEDEX ROTARY SOLENOIDS to choose from!

Model No.	2	3	4	5	6	7	8
Diameter inches	1⅛	1⅝	1⅝	1⅞	2¼	2¾	3⅜
Torque lbs.-inches	.4	1.0	1.7	4.0	7.5	25.0	54.0

Torque values for normal intermittent duty and 45° stroke.

Engineering data is available upon request.

WRITE FOR DESCRIPTIVE LITERATURE TODAY!

J. H. Leland INC.

123 WEBSTER STREET, DAYTON 2, OHIO

IN CANADA: MARSLAND Engineering Ltd., KITCHENER, ONTARIO

Index of PRODUCTS ADVERTISED

In This Issue

•

Continued from p. 481

Rubber .....2nd Cover, 55, 231 328, 419, 435

Rubber-Bonded-to-Metal 353

Rubber Coated Parts..... 252

Rubber Parts...38-39, 427, 428, 435, 456

Rust Proofing 8

S

Screw Fasteners 14, 447

Screws.....44, 74, 249, 266, 270, 346 394, 422, 450, 466

Screw Thread Inserts..... 447

Sealants 341

Sealers 115, 259-264

Seals...2nd Cover, 38-38, 80, 280, 304, 328 392, 426, 452, 468

Servomechanism Components ...308, 437

Shapes, Rolled Formed..... 248

Sheaves 32

Sheets
Metal.....10, 57, 97, 274, 479
Plastic 82, 130

Shims 123, 395

Silicone Rubber 103

Silicones 103, 305-306

Slides 300, 445

Solenoids 482

Specialty Fasteners (Pipe Hangers, Special Cold Headed Parts, etc.).14, 54 109, 132, 266, 346, 369, 394, 401, 432 436, 450, 455, 471

Speed Reducers..37, 72-73, 241, 255, 285 128, 239, 366, 393

Spindles 445

Spinning 289

Splines 117

Springs 372, 431, 446

Sprockets.....13, 370, 430, 457

Stampings.....289, 338, 383, 466

Steel
Alloy...15, 20-21, 28-29, 52-53, 62, 88 128, 366, 393
Carbon 98, 128, 329, 366
Coated 57, 366
Stainless.10, 28-29, 57, 95, 274, 335, 393

Strainers 446

Strip, Plastic 451

Strip, Metallic.....2, 10, 57, 98, 479

Structural Forms & Shapes..... 315

Studs 394, 459

Subcontracting Services 289

Index of

PRODUCTS ADVERTISED

In This Issue

•

Switches....12, 30, 94, 101-102, 116, 251 258, 307, 321, 373-374, 426 461

Swivel Joints 371

T

Tapes 272

Terminals & Terminal Boards..... 337

Testing Machines & Equipment.....100 250, 278

Thermostats.....11, 36A, 114, 319, 453

Timers.....122, 243, 251, 307, 486

Timing Motors 243, 486

Tools 453

Torque Converters 288, 412

Tracing Paper 281

Transmissions.....256, 292-393, 460

Traps (Steam) 120

Tubing
- Lock-Seam 405
- Plastic 451
- Seamless.....83, 315, 333, 418
- Welded 97

U

Universal Joints 382, 397

V

Valves
- Air..6, 253, 268-269, 277, 377, 391, 411
- Hydraulic.....6, 99, 253, 277, 377, 391 420, 422, 438, 444

Varnish 398, 454

W

Washers.....270, 331, 338, 349, 369

Wear Materials 78, 410

Welding
- Equipment.....267, 352, 361
- Nuts 428, 463
- Supplies.....352, 361, 483

Wheels 426

Whiteprinting Equipment 422

Wire.....10, 42-43, 383, 418, 479

Wire & Cable.....42-42, 63, 409, 423

Wire Cloth.....330, 439, 484

Wiring Devices.....373-374

Z

Zinc Coated Sheets 57, 329

Zinco Coated Strip.....57, 329

JOT NAME, TITLE AND ADDRESS IN THIS SPACE
TO START YOUR FREE "NELWELDER" SUBSCRIPTION
The top half of our dancing highlander will be seen on the cover of the May NELWELDER, industry's magazine of stud welding.
NELWELD
another way of saying..
WEE WELDER SAVES MONEY
You'll dance with glee when you see how thrifty it is to end-weld fasteners and projections the NELWELD® way. Cost-conscious engineers who specify this method save material, handling time, reduce drilling, and eliminate tapping. In construction, it's a money saver, too.
The best of the thrift stories are told monthly in the NELWELDER. Perhaps some of them will spark a bonnie short cut for you! The top of this advertisement is your subscription blank.
NELSON STUD WELDING
Division of Gregory Industries, Inc.
LORAIN, OHIO

ALABAMA WIRE

has
Die Casting
Facilities . . .

A typical example of our work is this aluminum spool which weighs 3.125 lbs.; has a flange diameter of 8″ and a 4″ barrel. If your volume of aluminum parts is considerable, or the tooling, machining, servicing or assembling of the part is expensive . . . we can help you cut costs with high pressure, aluminum die castings.

Quotations are made on your specs or perhaps we can help in design and engineering of a part you want die cast.

Write, wire or phone today.

ALABAMA WIRE CO., INC.

TERRACE STREET · P.O. BOX 562 P · FLORENCE, ALABAMA

Phone 3178

MANUFACTURERS OF METAL-MESH INSECT SCREENING

INDEX TO ADVERTISERS

This index is published as a convenience to the readers. Every care is taken to make it accurate but PRODUCT ENGINEERING assumes no responsibility for errors or omissions.

A

Accurate Spring Mfg. Co. 431
Adams & Westlake Co. 222
Advanced Vacuum Products, Inc., Div. of General Ceramics Corp. 367
Aeroquip Corp. 389
Airborne Accessories Corp. 410
Aircraft-Marine Products, Inc. 337
Alabama Wire Co., Inc. 484
Alemite 99
Allegheny Ludlum Steel Corp. 393
Allen-Bradley Co. 101-102
Allen Mfg. Co. 47
Allied Research Products, Inc. 246
Allied Wheel Products, Inc. 426
Allis-Chalmers Mfg. Co. 32, 46, 94
Allis Co., Louis 286
Aluminum Co. of America 430
American Brass Co. 92
American Chemical Paint Co., Metalworking Chemical Div. 254
American Crucible Products Co. 410
American Felt Co. 381
American Lava Corp. 287
American Screw Co. 249
American Smelting & Refining Co. 315
American Steel & Wire Div., U. S. Steel Corp. 52-53, 95
Amplex Mfg. Co., Div. Chrysler Corp. 118
Apex Machine & Tool Co. 397
Armco Steel Corp. 10
Armstrong Cork Co. 71, 106, 115, 272
Arrow-Hart & Hegeman Electric Co. 373-374
Atlantic Screw Works, Inc. 249
Atlas Chain & Mfg. Co. 370
Automatic Switch Co. 253
Automotive & Aircraft Div., American Chain & Cable Co. 350
Automotive Gear Works, Inc. 1
Aviation Developments, Inc. 462

B

B/W Controller Corp. 470
Babcock & Wilcox Co., Tubular Products Div. 333
Baldwin-Lima-Hamilton Corp., Loewy-Hydropress Div. 413
Bantam Bearings Div., Torrington Co. 96
Barksdale Valves 6
Beaver Precision Products, Inc. 402
Belden Mfg. Co. 409
Bellofram Corp. 468
Bethlehem Steel Co. 62
Blake & Johnson Co. 249
Boundbrook Oil-Less Bearing Co. 224
Bourns Laboratories 313
Bower Roller Bearing Div., Federal-Mogul-Bower Bearing, Inc. 271
Bridgeport Brass, Co. 81
Bruning Co., Inc., Charles 69, 85
Brush Electronics Co. 100, 278
Buffalo Bolt Co., Div. Buffalo Eclipse Corp. 471
Bundy Tubing Co. 405
Bunting Brass & Bronze Co. 375

C

Cambridge Wire Cloth Co. 439
Cannon Electric Co. 303
Carboloy Dept., General Electric Co. 295
Carpenter Steel Co. 36B, 88
Central Foundry Div., General Motors Corp. 20-21
Central Screw Co. 249
Century Electric Co. 357
Cerro De Pasco Corp. 444
Chain Belt Co. 339-340
Char-Lynn Co. 438
Chase Brass & Copper Co. 56
Chatillon & Sons, John 372
Chicago Molded Products Corp. 130
Chicago Rawhide Mfg. Co. ..... 2nd Cover
Chiksan Co. 371
Ciba Co., Inc., Plastics Div. 443
Clapp & Poliak, Inc. 384
Clark Controller Co. 112
Clearprint Paper Co. 281
Cleveland Cap Screw Co. 394
Climax Molybdenum Co. 104
Clipper Belt Lacer Co. 485

INDEX TO ADVERTISERS

Columbia-Geneva Steel Div., U. S. Steel Corp. 52-53, 95
Cone-Drive Gears Div., Michigan Tool Co. 255
Continental Felt Co. 438
Continental Rubber Works 435
Continental Screw Co. 249
Copper & Brass Research Association 84
Corning Glass Works 355
Cramer Co., Inc., R. W. 243
Crucible Steel Co. of America 335
Cullman Wheel Co. 430
Cuno Engineering Corp., Super Auto Klean Div. 386
Curtis Universal Joint Co., Inc. 382

D

Darling Valve & Mfg. Co. 334
Dayton Rubber Co. 86-87
DeJur Amsco Corp. 467
DeLaval Steam Turbine Co. 241
Delco Products Div., General Motors Corp. 48
Detroit Power Screwdriver Co. 480
Dexter & Sons, C. H. 79
Doehler-Jarvis Div., National Lead Co. 322-323
Douglas Aircraft Co., Inc. 380
Dow Chemical Co. 82
Dow Corning Corp. 305-306
DuPont De Nemours & Co., Inc., E. I., Elastomers 231
DuPont de Nemours & Co., Inc., E. I. Fabrics Div. 93
DuPont de Nemours & Co., Inc., E. I. Film Department 49
DuPont de Nemours & Co., Inc., E. I. (Plastics) 67-68
DuPont de Nemours & Co., Inc., E. I. Textile Fibers 376
Durakool, Inc. 307
Durametallic Corp. 304

E

Eastman Kodak Co., Special Products Sales Div. 250
Eastman Mfg. Co. 273
Eaton Mfg. Co., Foundry Div. 320
Ebert Electronics Co. 438
Elastic Stop Nut Corp. of America 41
Elco Tool & Screw Corp. 249, 466
Electro Dynamics Div., General Dynamics Corp. 344
Electrofilm, Inc. 432
Electro Switch Corp. 321
Emerson Electric Mfg. Co. 302
Engineered Precision Casting Co. 437
Enjay Co., Inc. 55
Erico Products Co. 456

F

Fafnir Bearing Co. 235
Fairbanks, Morse & Co., Magneto Div. 464
Fairchild Aircraft Div., Fairchild Engine & Airplane Corp 440
Farrel-Birmingham Co., Inc. 285
Farval Corp. 45
Fasteners, Inc. 459
Faultless Caster Corp. 407
Federal Bearings Co., Inc. 332
Federal Die Casting Co. 324
Federal Mogul Div., Federal-Mogul-Bower Bearing, Inc. 331
Federated Metals Div., American Smelting & Refining Co. 406
Fenwal, Inc. 36A
Ferguson Machine & Tool Co. 284
Firestone Plastics Co., Chemical Sales Div., Div. of Firestone Tire & Rubber Co. 294
Foote Bros. Gear & Machine Corp. 37
Foote Gear Works, Inc., Brad 433
Ford Instrument Co., Div. of Sperry-Rand Corp. 308
Ford Motor Co., Industrial Engine Dept. 417
Franklin Dales Co. 453
Frenchtown Porcelain Co. 354
Fulton Sylphon Div., Robertshaw Fulton Controls Co. 379

G

Gamble Brothers 276
Garlock Packing Co. 392
Garrett Co., Inc., George K. 338

(Continued on Pg. 486)

let us make a

Clipper *joint . . .*

for you

Are you looking for a better, faster way to fasten belts, aprons, tapes or ribbons? Would you like to slash maintenance time by putting an easy-to-fasten joint in endless belts? The fastest way to join these ends is with Clipper Hooks and Lacers.

Long used for lacing power transmission belting, Clipper fasteners are now proving their cost-cutting value in materials handling equipment, automatic pin setters, laundry equipment, food harvesting and processing equipment and in many other applications.

They produce a smooth, flexible joint in a hurry.

Let us demonstrate the advantages of a Clipper joint on the product of your choice. Send us a small sample (or the complete belt, apron, tape, or what have you) and we'll make you a Clipper joint FREE, without obligation.

Write, wire or call today for details and literature.

Ask your Industrial Distributor for Clipper Products

Clipper BELT LACER COMPANY

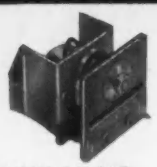
986 Front Ave., N. W., Grand Rapids 2, Michigan

When you measure

TIME

look to

HAYDON*



TIME DELAY RELAYS

5900 Series: For time delay or interval timing in ranges from 0 to 10 minutes.

INTERVAL TIMERS

8006 Series: Times intervals from 60 seconds to two weeks with exactness.

ELAPSED TIME INDICATORS

5700 Series: Registers passage of time in minutes and tenths of minutes and hours with mathematical regularity.

TIMING MOTORS

Compact HAYDON Timing Motors that can be operated continuously in any position drive all HAYDON Timing Devices. HAYDON specializes in timing; engineers and builds only timing components; has the "know how" to put time to work for you.

TAKE TIME NOW to write for the name of your HAYDON Timing Specialist, and for HAYDON Catalog.

HAYDON AT TORRINGTON

A SUBSIDIARY OF GENERAL TIME CORP.

HEADQUARTERS FOR **TIMING**

HAYDON Manufacturing Company, Inc.

3128 ELM STREET, TORRINGTON, CONN.

☐ Send me "Electric Timing Devices" catalog.

☐ Send me name of HAYDON Timing Specialist.

NAME_____

TITLE_____

COMPANY_____

CO. ADDRESS_____

CITY_____ ZONE___ STATE_____

*Trademark Reg. U.S. Patent Office

INDEX TO ADVERTISERS

(Continued from Pg. 485)

Gast Mfg. Corp. 301
General Aniline & Film Corp., Ozalid Div. 422
General Dynamics Corp., Electro Dynamics Div. 344
General Electric Co., Apparatus Dept. ..22-23, 76-77, 90-91, 108, 124-125, 298-299
General Electric Co., Construction Materials Div. 42-43
General Industries Co. 360
General Mills, Inc., Mechanical Div. 408
General Plate Div., Metals & Controls Corp. 31
Gering Products, Inc., Custom Extrusions Div. 318
Gerotor May Corp. 292-293
Gilman, Inc., Russell T. 443
Gits Bros. Mfg. Co. 247
Goodrich Co., B. F. 105
Grand Rapids Varnish Corp. 398
Grant Pulley & Hardware Co. 300
Great Lakes Screw Corp. 249
Great Lakes Steel Corp., Div. National Steel Corp. 239
Greene, Tweed & Co. 426
Grip Nut Co. 442
Grotnes Machine Works 368
Gulton Industries 63

H

Hagen Manufacturing Co., Subs. of Eagle Signal Corp. 251
Hannifin Corp. 391
Harper Co., H. M. 249, 270
Harrison Radiator Div., General Motors Corp. 107
Harvey Aluminum Sales, Inc. 351
Haydon Mfg. Co., Inc. 486
Haynes Stellite Co., Div. of Union Carbide & Carbon Corp. 78
Helm Co. 50
Heinze Electric Co. 444
Heli-Coil Corp. 447
Heyman Mfg. Co. 436
Hilliard Corp. 387
Hitemp Wires, Inc. 423
Hoke, Inc. 444
Holtzer-Cabot Div. of Nat'l Pneumatic Co., Inc. 437
Hommel Co., O. 453
Hoover Ball & Bearing Co. 276
Houghton & Co., E. F. 257
Houghton Laboratories, Inc. 425
Howard Industries, Inc. 275
Howell Electrical Motors Co. 362
Hughes Research & Development Laboratories 476, 487
Hyatt Bearings Div., General Motors Corp. 26-27

I

Illinois Gear & Machine Co. 347
Indiana Steel Products Co. 416
Industrial Timer Corp. 122
Instrument Specialities Co., Inc. 446
International Harvester Co., Industrial Power Div. 317
International Nickel Co., Inc. 70

J

Jahn Mfg. Co., B 296
Janette Manufacturing Co. 290-291
Johnson Corp. 454
Jones & Loughlin Steel Corp. 343

K

Kaiser Aluminum & Chemical Corp. 24-25, 309-312
Kalamazoo Div., N. Y. Airbrake Co. 109
Kaydon Engineering Corp. 245
Kilian Mfg. Corp. 434
Koven & Bro., Inc., L. O. 359
Kraissl Co., Inc. 446

L

L. O. F. Glass Fibers Co. 490
Laminated Shim Co., Inc. 123, 395
Lamson & Sessions Co. 249
LaSalle Steel Co. 128
Leiman Brothers, Inc. 468
Leland Electric Co., Div., American Machine & Foundry Co. 400

INDEX TO ADVERTISERS

Leland, Inc., G. H. 482
Lewellen Mfg. Co. 256
Licon Div., Illinois Tool Works 116
Lincoln Electric Co. 352
Linde Air Products Co., Div. of Union Carbide & Carbon Corp. 361
Linear, Inc. 448
Link-Belt Co. 13, 72-73, 89
Long Manufacturing Div., Borg-Warner Corp. 412
Lord Mfg. Co. 353
Lukens Steel Co. 366

M

McGill Mfg. Co., Inc. 233
McGraw-Hill Book Co., Inc. 462
MacLean-Fogg Lock Nut Co. 436
Magnesium Co. of America 434
Magnetic Amplifiers, Inc. 478
Makepeace Co., D. E., Div. Union Plate & Wire Co. 464
Malleable Founders' Society 477
Mallory & Co., Inc., P. R. 4, 40
Manhattan Rubber Co. 38-39
Marble-Card Electric Co. 430
Marco Industries, Inc. 466
Martin-Rockwell Corp. 415
Marquette Metal Products Co., Subs. of Curtiss-Wright Corp. 265
Marvel Engineering Co. 378
Master Electric Co. ..... 3rd Cover
Matthews & Co., Inc., Jas. H. 470
Metals & Controls Corp., General Plate Div. 31
Metals & Controls Corp., Spencer Thermostat Div. 30
Metal & Thermit Corp. 421
Meyercord Co., Name Plate Div. 464
Mica Insulator Co. 365
Michigan Tool Co., Cone Drive Gears Div. 255
Micromatic Hone Corp. 358
Micro Switch Div., Minneapolis-Honeywell Regulator Co. 12
Midland Industrial Finshes Co. 454
Midland Steel Products Co. 463
Miller Fluid Power Co. 121
Minneapolis Honeywell Regulator Co., Industrial Div. 319
Minneapolis-Moline 396
Minnesota Mining & Mfg. Co. 259-264
Monsanto Chemical Co. 18-19
Moraine Products Div., General Motors Corp. 113
Morganite, Inc. 429
Morse Chain Co. 279
Mt. Vernon Die Casting Corp. 404

N

National Lock Co. 249
National Machine Products Co. 432
National Motor Bearing Co., Inc. 80
National Pneumatic Co., Inc., Holtzer-Cabot Motor Div. 437
National Screw & Mfg. Co. 249, 346
National Standard Co. 98
National Tube Div., U. S. Steel Corp. 52-53, 83, 95
National Vulcanized Fibre Co. 342
Nelson Stud Welding 483
Newark Wire Cloth Co. 330
New Departure Div., General Motors Corp. 134
The New York Air Brake Co. 109
Ney Co., J. M. 304
Nice Ball Bearing Co. 448
Nicholson & Co., W. H. 120
Norgren Co., C. A. 268-269

O

Ohio Nut & Bolt Co. 428
Onan & Sons, Inc., D. W. 441

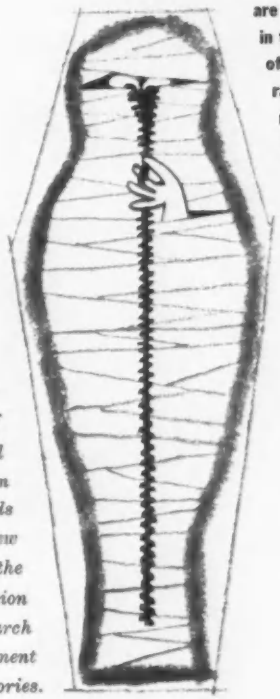
P

Packard Electric Div., General Motors Corp. 16
Parker Appliance Co. 280
Parker-Kalon Div., General American Transportation Corp. 74, 249
Parker Rust Proof Co. 8
Parker Stamp Work, Inc. 449
Parker White-Metal Co. 316
Pass & Seymour, Inc. 426
Peerless Electric Co., Fan & Blower Div. 442
Peerless Electric Co., Motor Div. 454
Penn Metal Co., Inc. 345

(Continued on Pg. 488)

ingenious packaging

The most advanced developments in electronics are being made in the sphere of airborne radar and related ground control systems because of military emphasis.



Further applications of electromechanical techniques in these fields are creating new openings in the Systems Division of Hughes Research and Development Laboratories.

Engineers who have demonstrated ingenuity and inventive ability will find interest in areas of work that call for devising reliable, maintainable, manufacturable designs for precision equipment developed at Hughes Research and Development Laboratories. The design of this equipment, manufactured at Hughes, involves mechanical, electro-mechanical, electronic, microwave and computing problems. Design also requires the use of such advanced techniques as subminiaturization, unitized "plug-in" construction, with emphasis on design for volume production. Knowledge of electronic components, materials, finishes, and military specifications is useful.

HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES

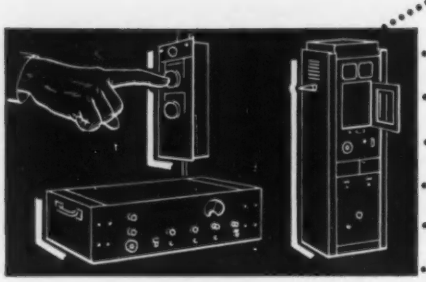
SCIENTIFIC STAFF RELATIONS

HUGHES AIRCRAFT COMPANY

Culver City, Los Angeles County, California

ELECTRICAL / ONIC

CONTROL?
AUTOMATION?
INSPECTION?
DISTRIBUTION?
MEASURING?
TESTING?



call upon our **SUPERIOR** willingness to design

Slip Ring Assemblies that fit your job.

• *Silver alloy brushes by Superior have low contact resistance, low friction, and low noise level. They live long.*

The word is getting around that Superior really welcomes an invitation to study slip ring applications. Seen above is one of many such jobs which have solved problems for the manufacturers of end products. Sometimes we build a slip ring assembly which follows the customer's design, or we will design and build an assembly which suits your equipment. Practically any size or design can be met. Let us quote you on a *complete Superior package* unit including rings, brush holders, and brushes of our own manufacture.

SUPERIOR CARBON PRODUCTS, INC.
9115 GEORGE AVENUE • CLEVELAND 5, OHIO

SCP
SUPERIOR CARBON BRUSHES
"Since 1919"

INDEX TO ADVERTISERS

(Continued from Pg. 487)

Perfection Gear Co., American Stock Gear Div. 314
Perkins F. (Canada) Ltd. 119
Perkins Machine & Gear Co. 457
Phalo Plastics Corp. 450
Pheoll Mfg. Co. 249
Phoenix Manufacturing Co., Rubber Products Div. 252
Pioneer Pump Div. of Detroit Harvester Co. 465
Polymer Corp. of Pennsylvania 451
Porcelain Enamel Institute, In. 403
Precision Metalsmiths, Inc. 356
Presstite Engineering Co. 341
Process Gear Co., Inc. 424
Product Engineering 126-127
Progressive Mfg. Co., Div. of The Torrington Co. 450
Pure Carbon Co., Inc. 363
Purolator Products, Inc. 452

R

Rawson Coupling Div., O. S. Walker, Inc. 446
Raybestos-Manhattan Inc. Equipment Sales Div. 38-39
Manhattan Rubber Div. Packings Div.
Raybestos-Manhattan, Inc. Packing Div. 38-39
Reeves Instrument Corp., Subs. Dynamatic Corp. of America 456
Reeves Div., Reliance Electric & Engrg. Co. 327
Reliance Electric & Engineering Co. 325
Republic Steel Corp. 28-29
Reuland Electric Co. 348
Revere Copper & Brass, Inc. 2, 97
Revere Corp. of America, Subs. of Neptune Meter Co. 461
Richardson Co. 388
Riverside Metal Co., Div. H. K. Porter Co., Inc. 479
Rivett Lathe & Grinder, Inc. 277
Rockford Clutch Div., Borg-Warner Corp. 458
Roll Formed Products Co. 248
Rubatex Div., Great American Industries, Inc. 328
Russell, Burdsall & Ward Bolt & Nut Co. 266
Ruthman Machinery Co. 324

S

SKF Industries, Inc. 282-283
Saginaw Steering Gear Div., General Motors Corp. 117
Salsbury Corp. 460
Schrader's Son, A., Div. Scovill Mfg. Co. 411
Sciaky Brothers, Inc. 267
Scintilla Electrical Conn. Div., Bendix Aviation Corp. 436
Scovill Mfg. Co. 249, 455
Screw Research Association 249
Servo-Speed Div., Electro Devices, Inc. 425
Shakeproof Div. of Illinois Tool Works 249, 349
Sharon Steel Corp. 57
Silicones Div., Union Carbide & Carbon Corp. 103
Simmons Fastener Corp. 54
Sinko Mfg. & Tool Co. 458
Skinner Electric Valve Div., Skinner Chuck Co. 377
Smith Corp., A. O., Electric Motor Div. 58-59
Society of the Plastics Industry, Inc. 424
South Chester Corp., Southco Div. ... 14
Southington Hardware Mfg. Co. 249
Sparta Manufacturing Co. 460
Speer Carbon Co. 440
Spencer Thermostat Div., Metals & Controls Corp. 30
Sperry Products, Inc. 445
Spincraft, Inc. 289
Stackpole Carbon Co. 469
Stalwart Rubber Co. 456
Standard Pressed Steel Co. 44, 66
Stephens-Adamson Mfg. Co., Sealmaster Bearings Div. 385
Sterling Bolt Co. 249
Stevens Mfg. Co., Inc. 11
Stewart Warner Corp. (Alemite) 99
Stratoflo Products, Inc. 422
Stromberg-Carlson Div. of General Dynamics Corp. 390
Sturtevant Co., P. A. 453
Superior Carbon Products Co. 488

INDEX TO ADVERTISERS

Sylvania Electric Products, Inc., Parts Div. 383
Syncro-Start Products, Inc. 448
Synthane Corp. 297

T

Taylor Fibre Co. 336
Tennessee Coal & Iron Div., U. S. Steel Corp. 52-53, 95
Thermoid Co. 427
Thiokol Chemical Corp. 419
Thomas Publishing Co. 460
Thompson-Bremer & Co., Subs. of American Machine & Foundry Co. 369
Timken-Detroit Brake Co., Rockwell Spring & Axle Co. 226
Timken Roller Bearing Co. (Industrial) 15
Tinnerman Products, Inc. 132
Tomkins-Johnson Co. 326
Torrington Co., Bantam Bearings Div. 96
Turco Products, Inc. 414
Tuthill Pump Co. 481
Twin Disc Clutch Co. 288
Tyer Rubber Co. 428

U

Unimax Switch Div., L. W. Maxson Corp. 258
Union Carbide & Carbon Co.
Haynes Stellite Co. 78
Linde Air Products Co. 361
Silicone Div. 103
United-Carr Fastener Corp. 401
U. S. Electrical Motors, Inc. 51
U. S. Graphite Co. ..... 4th Cover
U. S. Rubber Co. 60, 75
U. S. Steel Corp. 52-53, 95
U. S. Steel Export Co. 52-53, 95
U. S. Steel Supply Div., U. S. Steel Corp. 52-53, 95
United Wire & Supply Corp. 418
Universal Drafting Machine Co. 338
Universal Gear Div., Novo Pump & Engine Co. 468
Universal Oil Seal Co. 452

V

Veeder-Root, Inc. 17
Vellumoid Co. 442
Vickers, Inc., Div. of Sperry-Rand Corp. 420
Viking Pump Co. 433

W

Wagner Electric Corp. 110-111
Waldes-Kohinoor, Inc. 61
Waldron Corp., John 399
Wales-Beech Corp. 249
Wales-Strippit Corp. 489
Washington Steel Corp. 274
Weckesser Co. 422
Weirton Steel Co., Div. National Steel Corp. 329
Westinghouse Electric Corp. 64-65
White Dental Mfg. Co., S. S. 237
Wiegand Co., Edwin L., Ind. Div. 308
Wilcolator Co. 114
Winsmith, Inc. 364
Winzeler Mfg. & Tool Co. 466
World Bestos Div., Firestone Tire & Rubber Co. 424

■

PROFESSIONAL SERVICES 472

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

EMPOYMENT OPPORTUNITIES 472-475

EQUIPMENT (Used or Surplus New) For Sale 472

WANTED Equipment 472

BUSINESS OPPORTUNITIES

Index to Advertisers begins on P 484
Products Index begins on P 476

Don't Waste Hours

ADJUSTING AND SETTING CONVENTIONAL DIES

when the "WALES-WAY" takes ONLY MINUTES!

Die set ups are ready for action IN LESS THAN A MINUTE.

Punches, stripping guides, springs and guide buttons are all component parts of the Units . . . not attached to the press ram. WALES UNITS have a standard shut height of 5½" so only one adjustment of the ram is needed.

WALES UNITS may be used over and over again in infinite variety of PUNCHING, NOTCHING, NIBBLING jobs. This method requires a minimum of equipment at a minimum of cost.

A WALES TOOL
TAKES MINUTES TO SET
AND ELIMINATES HOURS OF
• set-up time
• press down time
• setting stripping guides
• counter-boring for springs
• setting heavy stripper plates
• die buttons, etc., etc.

WALES MOBILE TRUCK UNITS will demonstrate WALES-WAY methods right at your door. No obligation.

Send for BULLETIN NO. 14C

Illustrated with actual job work and full of interesting data and suggestions that you can adopt for your shop.

WALES Strippit CORPORATION
"...the Wales-Way is the PLUS-PROFIT way"
345 PAYNE AVE. — North Tonawanda, N.Y.
WALES-STRIPPIT OF CANADA LTD., HAMILTON, ONT.

INSULATION news from L·O·F GLASS FIBERS COMPANY

S-h-h-h!

In Evinrude's Big Twin Aquasonic outboard motors, L·O·F Glass Fibers' insulation forms the carburetor intake silencers that help hold objectionable engine noise to a minimum.

Evinrude makes outboard motors "whisper" with L·O·F Glass Fibers' insulation

Got a noise problem? Like Evinrude's engineers, you may find the perfect answer in L·O·F Glass Fibers' Microlite or Super·Fine insulation!

Evinrude chose Microlite insulation for three reasons:

1. It has high acoustical efficiency—with millions of tiny dead-air cells trapped in its longer, finer glass fibers.
2. It resists air erosion even at high intake velocities.
3. It is easily die-cut to fit irregularly shaped housings.

Whether your insulating problem is acoustical or thermal, Super·Fine and Microlite offer efficient solutions *plus* all these design advantages . . .

- light weight
- low density
- high resiliency
- heat resistance
- low space requirement
- easy handling
- easy fabrication
- resistance to moisture and settling

For more information on design possibilities of L·O·F Glass Fibers' insulation, contact our nearest office; or write: *L·O·F Glass Fibers Company, Dept. 4-46, 1810 Madison Ave., Toledo 1, Ohio.*

LOF GLASS FIBERS SUPER-FINE INSULATION

Visit our booth at The Design Engineering Show, Philadelphia Convention Hall, May 14-17.

L·O·F GLASS FIBERS COMPANY

TOLEDO 1, OHIO

Makers of glass fibers by the exclusive "Electronic-Extrusion" process

NEW 3-POINT EASY-TO-USE READER SERVICE TO HELP YOU

. . . find out more about the New Materials and Components described

. . . obtain copies of new catalog and bulletins

. . . get more information about products advertised in this issue

Now, one of these handy prepaid postcards will bring you more information about any product advertised or mentioned editorially in this issue of *Product Engineering*.

Here's How to Use the Card

For your copy of any new catalog or bulletin, circle key numbers in the space indicated. Bulletins are described on pages 352-378.

To get more data about new Components, Materials and Parts fully described on pages 228-348, just circle the appropriate key number.

To get more information about advertised products, circle the page number of the advertisement in which you are interested. If more than one advertisement is located on a single page, letters preceding number identify each advertisement. Key: T—Top; B—Bottom; R—Right; L—Left; TL—Top; Left BL—Bottom left; TR—Top right; BR—Bottom right.

For specialized data . . . prices, sizes available, nearest source of supply, etc. . . . do not circle key number but indicate your needs in the space alloted at the bottom of the card. Use this space, too, if information about a specific product among several mentioned in an advertisement is desired.

PRINT or TYPE your address before mailing

FIRST CLASS
PERMIT NO. 64
(Sec. 34.9 P.L.&R.)
NEW YORK, N. Y.

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

-4¢ POSTAGE WILL BE PAID BY-

PRODUCT ENGINEERING
READER SERVICE DEPARTMENT
330 WEST 42nd ST.
NEW YORK 36, N. Y.

PLEASE TYPE OR PRINT

Name _____

Position _____

Company _____

Address _____

City & State _____ 4-58

NEW PRODUCTS... Description of these new engineering materials appear on pages 228-348. Circle key number for more data

1—D-c Motors and Generators
2—Plastic-Bound Permanent Magnets
3—Ceramic Permanent Magnets
4—Geared Joint for 45 to 315 Deg.
5—High Speed Magnetic Switch
6—Switch With Solenoid-Worked Detent
7—Right-Angle Tube Sockets
8—Self-Checking Monitoring System
9—Control Panel Wiring Conduit
10—Hardened AISI 1060 Steel Bars
11—External Miniature Connectors
12—Tantalum Capacitor
13—High-Current Vacuum Switch
14—Offset Spinning of Tubing
15—Switch With "Serpentine" Action
16—Pilot Lights
17—Printed Circuit Connectors
18—Flanged Pipe Connector
19—Liquid Spring
20—Vinyl Insulating Tubing
21—Fixed Voltage Supplies
22—A-c—D-c Digital Voltmeter
23—Hydraulic Power Unit
24—Reversing Switch
25—Pneumatic Transmitter
26—Counts Dozens
27—Low Torque Potentiometers
28—Tension Control Unit
29—Push-Type, 6 Amp Switch
30—Hydraulic Coupling
31—Double-Shaft ⅝ Hp Motor
32—Controls for Printed Circuits
33—Low Frequency Mount
34—Heat Resisting Diaphragms
35—Two Hose Fittings
36—Subminiature Clutch
37—Miniature Altitude Switch
38—High-Temperature Capacitors
39—Rigid PVC Pipe
40—Switchboard Clock
41—Gage for Dangerous Installations
42—Miniature Planetary Geared Motor
43—Ground Detector
44—Self-Aligning Bearing
45—Vibration Resistant Nuts
46—Throttling Valve
47—Silicon Photoelectric Cells
48—Miniature Coaxial Connectors
49—Two or Three-Position Switches
50—Subminiature Snap Switches
51—Medium-Carbon Die Steel
52—Elastomeric Adhesive
53—Metal Bonding Adhesive
54—Flexible Seamless Aluminum Tubing
55—Counterpoise Relay
56—Hydraulic Hose Fitting
57—Two Time Delay Relays
58—Automatic Marking Device
59—Bonding of Unlike Metals
60—Sealed Snap Switch
61—Double-Acting Cylinder
62—Jackscrew Locking Device
63—Silicon Power Rectifier
64—Knob Lock
65—Toggle Switch "Remembers"
66—Subminiature Pushbutton Switches
67—Extra Heavy Duty Rotary Switch

PRINT or TYPE your address before mailing

CIRCLE THESE NUMBERS FOR FURTHER INFORMATION ON PRODUCTS ADVERTISED

C2	1	2	4	6	8	10	11	12	13	14	15	16	17
18-9	20-1	22-3	24-5	26-7	28-9	30	31	32	33-6	36A	36B	37	38
L39	R39	40	41	42-3	44	45	46	47	48	49	50	51	52-3
54	55	56	57	58-9	60	61	62	63	64-5	66	67-8	69	70
71	72-3	74	75	76-7	78	79	80	81	82	83	84	85	86-7
88	89	90-1	92	93	94	95	96	97	98	99	100	101-2	103
104	105	106	107	108	109	110-1	112	113	114	115	116	117	118
119	120	121	122	123	124-5	128	130	132	134	222	224	226	231
233	235	237	239	243	245	246	247	248	249	250	251	252	253
254	255	256	257	258	259-64	265	266	267	268	269	270	271	272
273	274	275	L276	R276	277	278	279	280	281	282-3	284	285	286
287	288	289	290-1	292	293	294	295	296	297	298-9	300	301	302
303	TL304	BL304	305-6	307	L308	R308	309-10	311-2	313	314	315	316	317
318	319	320	321	322-3	TL324	BL324	325	326	327	328	329	330	331
332	333	334	335	336	337	L338	R338	339-40	341	342	343	344	345
346	347	348	349	350	351	352	353	354	355	356	357	358	359
360	361	362	363	364	365	366	367	368	369	370	371	372	373-4
375	376	377	378	379	381	382	383	384	385	386	387	388	389
390	391	392	393	394	395	396	397	398	399	400	401	L402	R402
403	404	405	406	407	408	409	L410	R410	411	412	413	414	415
416	417	418	419	420	421	L422	TR422	BR422	423	L424	TR424	BR424	L425
R425	L426	TR426	BR426	427	L428	R428	429	L430	TR430	BR430	431	L432	R432
TR433	BR433	T434	B434	435	T436	BL436	BR436	L437	R437	T438	BL438	BR438	439
440	441	L442	TR442	BR442	443	L444	TR444	BR444	L445	R445	L446	TR446	BR446
447	L448	TR448	BR448	449	L450	R450	451	L452	R452	TR453	BC453	BR453	L454
TR454	BR454	455	L456	TR456	BR456	457	L458	TR458	459	L460	TR460	BR460	461
L462	R462	463	L464	TR464	BR464	465	L466	TR466	BR466	467	L468	TR468	BR468
469	L470	TR470	471	477	478	479	480	481	482	483	484	485	486
488	489	490	C3	C4									

CIRCLE THESE NUMBERS FOR INFORMATION ON NEW PRODUCTS LISTED IN THIS ISSUE

1	2	3	4	5	6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21	22	23	24	25	26	27	28
29	30	31	32	33	34	35	36	37	38	39	40	41	42
43	44	45	46	47	48	49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93	94	95	96	97	98
99	100	101											

CIRCLE THESE NUMBERS FOR COPIES OF NEW BULLETINS LISTED IN THIS ISSUE

102	103	104	105	106	107	108	109	110	111	112	113	114	115
116	117	118	119	120	121	122	123	124	125	126	127	128	129
130	131	132	133	134	135	136	137	138	139	140	141	142	143
144	145	146	147	148	149	150	151	152	153	154	155	156	

Card expires June 1

CIRCLE THESE KEY NUMBERS FOR FURTHER DATA ON.....

CIRCLE THESE KEY NUMBERS FOR INFORMATION ABOUT.....

CIRCLE THESE KEY NUMBERS FOR YOUR COPIES OF.....

USE THIS SPACE TO INDICATE REQUIRED.....

68—Snap-In Control—Printed Circuits
69—Rubber-Cushioned Ball Bearings
70—Magnetic Bin Vibrators
71—Vibration-Resistant Socket Screw
72—Subminiature Potentiometer
73—Industrial Torque Converter
74—Solderless Connectors
75—Magnetic Amplifier Power Supply
76—Reversible Decade Counter
77—Add-and-Subtract Counter
78—High Output Alternator
79—Load Cells of 10,000 Lb Capacity
80—Hidden Panel Hinge
81—Thermal Relay
82—Four-Way Hydraulic Valve
83—Ball-Bearing Induction Motor
84—Snap-Action Switch
85—Adjustable Electric Vibrator
86—Miniature Electrolytic Capacitors
87—Single and Two-Circuit Switches
88—Switch Shorter Than Paper Clip
89—Photoelectric Unit
90—Polyester Foam
91—Instrument Switches
92—Mobile Rack for Drawings
93—D-c Power Supply
94—Chassis Kit
95—Tubeless D-c Power Supply
96—General Purpose Oscillograph
97—Inch-Millimeter Calculator
98—Strain Gage Kits
99—Circuit Designs on Acetate Sheets
100—Chronometric Hand Tachometer
101—Portable Volt-Ammeter
102—Special Nuts
103—Bottle Oilers and Oil Cups
104—High Yield Strength Steel
105—Expansion Joints
106—PVC Pipe Fittings and Flanges
107—Reversing Motors
108—Hardware

NEW BULLETINS . . . listed below are described on page 352-378. Circle key number for your copy.

109—Wire Gage and Footage Chart
110—Solenoid Valves
111—Interval Timers
112—Alloy and Stainless Steels
113—Electrical Specialties
114—Rheostat Potentiometers
115—Hoses, Fittings, Couplings
116—Permanent Magnets
117—Shell-Molded Castings
118—Silicon Rectifiers
119—Generators
120—Heat Exchangers
121—Spherical Bearings and Rod Ends
122—Hydraulic Torque Converter
123—Gages
124—Pressure-Filled Metal O-Ring
125—Variable Speed Reducer
126—Stainless Strip
127—Aluminum Extrusions
128—Self-Tapping Inserts
129—Speed Reducers
130—O-Rings
131—Fluid Power Components
132—Research and Development

PRINT or TYPE your address before mailing

PRODUCTS ADVERTISED

CIRCLE THESE NUMBERS FOR FURTHER INFORMATION ON PRODUCTS ADVERTISED

C2	1	2	4	6	8	10	11	12	13	14	15	16	17
18-9	20-1	22-3	24-5	26-7	28-9	30	31	32	33-6	36A	36B	37	38
L39	R39	40	41	42-3	44	45	46	47	48	49	50	51	52-3
54	55	56	57	58-9	60	61	62	63	64-5	66	67-8	69	70
71	72-3	74	75	76-7	78	79	80	81	82	83	84	85	86-7
88	89	90-1	92	93	94	95	96	97	98	90	100	101-2	103
104	105	106	107	108	109	110-1	112	113	114	115	116	117	118
119	120	121	122	123	124-5	128	130	132	134	222	224	226	231
233	235	237	239	243	245	246	247	248	249	250	251	252	253
254	255	256	257	258	259-64	265	266	267	268	269	270	271	272
273	274	275	L276	R276	277	278	279	280	281	282-3	284	285	286
287	288	289	290-1	292	293	294	295	296	297	298-9	300	301	302
303	TL304	BL304	305-6	307	L308	R308	309-10	311-2	313	314	315	316	317
318	319	320	321	322-3	TL324	BL324	325	326	327	328	329	330	331
332	333	334	335	336	337	L338	R338	339-40	341	342	343	344	345
346	347	348	349	350	351	352	353	354	355	356	357	358	359
360	361	362	363	364	365	366	367	368	369	370	371	372	373-4
375	376	377	378	379	381	382	383	384	385	386	387	388	389
390	391	392	393	394	395	396	397	398	399	400	401	L402	R402
403	404	405	406	407	408	409	L410	R410	411	412	413	414	415
416	417	418	419	420	421	L422	TR422	BR422	423	L424	TR424	BR424	L425
R425	L426	TR426	BR426	427	L428	R428	429	L430	TR430	BR430	431	L432	R432
TR433	BR433	T434	B434	435	T436	BL436	BR436	L437	R437	T438	BL438	BR438	439
440	441	L442	TR442	BR442	443	L444	TR444	BR444	L445	R445	L446	TR446	BR446
447	L448	TR448	BR448	449	L450	R450	451	L452	R452	TR453	BC453	BR453	L454
TR454	BR454	455	L456	TR456	BR456	457	L458	TR458	459	L460	TR460	BR460	461
L462	R462	463	L464	TR464	BR464	465	L466	TR466	BR466	467	L468	TR468	BR468
469	L470	TR470	471	477	478	479	480	481	482	483	484	485	486
488	489	490	C3	C4									

NEW PRODUCTS . . .

CIRCLE THESE NUMBERS FOR INFORMATION ON NEW PRODUCTS LISTED IN THIS ISSUE

1	2	3	4	5	6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21	22	23	24	25	26	27	28
29	30	31	32	33	34	35	36	37	38	39	40	41	42
43	44	45	46	47	48	49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93	94	95	96	97	98
99	100	101											

NEW BULLETINS . . .

CIRCLE THESE NUMBERS FOR COPIES OF NEW BULLETINS LISTED IN THIS ISSUE

102	103	104	105	106	107	108	109	110	111	112	113	114	115
116	117	118	119	120	121	122	123	124	125	126	127	128	130
130	131	132	133	134	135	136	137	138	139	140	141	142	143
144	145	146	147	148	149	150	151	152	153	154	155	156	

SPECIFIC DATA . . .

Card expires June 1

133—Epoxy Adhesives
134—Aluminum Mill Products
135—Product Literature Directory
136—Machine Tool Limit Switch
137—Magnetic Chucks
138—Nickel-Cadmium Battery
139—Printed Circuit Connector
140—Custom Built Cylinders
141—Nylon Tube Fitting
142—Rubber-In-Shear Mounts
143—Chemical Rubber Products
144—Selenium Rectifiers
145—Heating Elements
146—Potentiometer
147—Carbon and Alloy Steels Compared
148—Fire-Resistant Pulleys
149—Multiple V-Belt Drive
150—Hydraulic Cylinders
151—Bushings
151—Plastic Pipe
153—Constant-Torque Spring Motor
154—Air Control Valves
155—Plate Magnets
156—Ratchet Drive Lubricator

USE THIS SERVICE

. . . . to get your copies of new catalogs and Bulletins

. . . . for information on New Products listed in this issue

. . . . for more information about products advertised in this issue

PRINT or TYPE your address before mailing

FIRST CLASS
PERMIT NO. 64
(Sec. 34.9 P.L.&R.)
NEW YORK, N. Y.

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

—4¢ POSTAGE WILL BE PAID BY—

PRODUCT ENGINEERING
READER SERVICE DEPARTMENT
330 WEST 42nd ST.
NEW YORK 36, N. Y.

PLEASE TYPE OR PRINT

Name _____

Position _____

Company _____

Address _____

City & State _____ 4-56

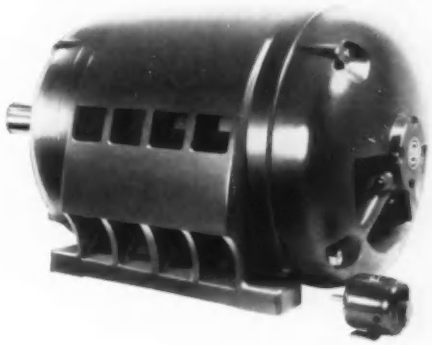
Requests for information made through *Product Engineering* Reader's Service will be forwarded to the manufacturer as quickly as we can process them. If you write directly to the manufacturer, please identify advertisement by issue and page number to facilitate reply.

You Name It—Thousands of Ratings

From 1/8 to 400 H. P.

See MASTER for a selection of motor drives that you can get nowhere else—for specialized power drives unequalled for flexibility, compactness and performance. See Master for the right horsepower, right shaft speed, right mounting features—to add salability to your products, efficiency to your plant equipment.

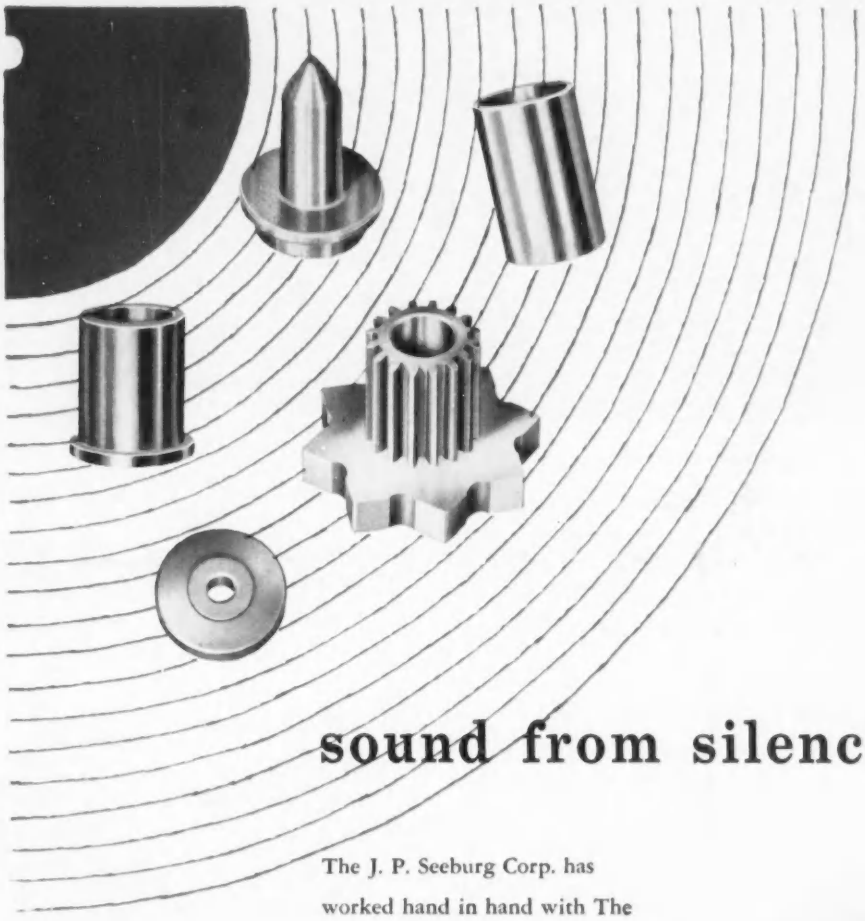
Master components are designed to combine in one compact unit to suit your needs exactly—all the way up to 400 H. P. Just ask us for information.



Motor Ratings	⅛ to 400 H.P. All phases, voltages, and frequencies.
Motor Types	Squirrel cage, slip ring, synchronous, repulsion-start induction, capacitor, direct current.
Construction	Open, enclosed, splash-proof, fan-cooled, explosion-proof, special purpose.
Speeds	Single-speed, multi-speed, and variable speed.
Installation	Horizontal or vertical, with or without flanges and other features.
Power Drive Features	Electric brakes (2 types)—5 types of gear reduction up to 432 to 1 ratio. Mechanical and electronic variable speed units—fluid drives—every type of mounting.

THE MASTER ELECTRIC COMPANY
Dayton 1, Ohio

MASTER ELECTRIC MOTORS



sound from silence . . . .

The J. P. Seeburg Corp. has worked hand in hand with The United States Graphite Company in developing self lubricating bearings and parts which meet the exacting requirements of the most successful high fidelity coin operated phonograph made today.

GRAMIX®

products from powder metallurgy

112

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN